लाल बहादुर शास्त्री प्रशासन अकादमी
Lal Bahadur Shastri Academy of Administration
मसूरी
MUSSOORIE

पुस्तकालय
LIBRARY

अवाप्ति संख्या
Accession No. ~~1146~~ 118875
वर्ग संख्या
Class No. R 630·03
पुस्तक संख्या
Book No. Sta
V·1

THE STANDARD CYCLOPEDIA
OF MODERN AGRICULTURE
AND RURAL ECONOMY

THE
STANDARD CYCLOPEDIA OF
MODERN AGRICULTURE
AND RURAL ECONOMY

BY THE MOST DISTINGUISHED
AUTHORITIES AND SPECIALISTS
UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

F.H.A.S. F.R.S.E. PRINCIPAL OF THE WEST OF SCOTLAND
AGRICULTURAL COLLEGE GLASGOW

VOLUME I
A—AUR

THE GRESHAM PUBLISHING COMPANY
34 AND 35 SOUTHAMPTON STREET STRAND LONDON
1909

LIST OF PLATES

VOLUME I

PAGE

INSECTS—I (*Coloured*) - - - - - - - - *Frontispiece*

ABERDEEN-ANGUS BULL—"MARAMERE" - - - - - - 4

ABERDEEN-ANGUS COW—"BARTONIA OF GLAMIS" - - - - 4

PHASES OF THE CART-HORSE WALK - - - - - - - 46

AGE OF ANIMALS—I. DENTITION OF THE HORSE - - - - - 56

AGE OF ANIMALS—II. DENTITION OF THE OX - - - - - 56

AGE OF ANIMALS—III. DENTITION OF THE SHEEP AND DOG - - 58

AGE OF ANIMALS—IV. DENTITION OF THE PIG - - - - - 58

GRASSES—I (*Coloured*) - - - - - - - - - - 90

SEEDS OF GRASSES—I - - - - - - - - - - 92

SUSSEX DRAUGHT OXEN IN THE HARVEST FIELD - - - - - 138

APPLES (*Coloured*) - - - - - - - - - - 172

ARAB STALLION—"MESAOUD" - - - - - - - - 180

ARAB MARE—"BOZRA" - - - - - - - - - 180

EWART'S DONKEY - - - - - - - - - - 222

ONAGER - - - - - - - - - - - - 222

ATAVISM - - - - - - - - - - - - 230

LIST OF CONTRIBUTORS

VOLUME I

The contributors sign by their initials at the conclusion of their respective articles. Those in the present volume are as follows:—

A. J. S.	**Aubrey J. Spencer**, M.A.(Oxon.), Barrister-at-Law, Lincoln's Inn, London; Editor of Dixon's "Law of the Farm", &c.
A. N. M'A.	**A. N. M'Alpine**, B.Sc.(Lond.), Assoc.R.C.S., Professor of Botany, West of Scotland Agricultural College, Consulting Botanist to the Highland and Agricultural Society of Scotland; Author of "A Botanical Atlas", &c.
C. E. C.	**Charles E. Curtis**, F.S.I., formerly Professor of Estate Management at the College of Agriculture, Downton; Author of "Estate Management", "Valuation of Tenant Right", &c.
D. B.	**David Bruce**, M.A., LL.B., Lecturer in Agricultural Law, West of Scotland Agricultural College.
E. B.	**Edward Brown**, F.L.S., Assistant Director and Lecturer on Poultry at the University College, Reading, Secretary of the National Poultry Organization.
E. J. R.	**E. J. Russell**, D.Sc., Rothamsted Experimental Station.
F. E. F.	**F. E. Fritsch**, D.Sc., Ph.D., F.L.S., Assistant Professor of Botany, University College, London.
F. V. T.	**Professor F. V. Theobald**, M.A.(Cantab.), F.E.S., Vice-Principal of and Zoologist to the S.-E. Agricultural College, Wye; Author of "Agricultural Zoology".
G. A. J. C.	**Grenville A. J. Cole**, F.G.S., Professor of Geology in the Royal College of Science for Ireland, Director of the Geological Survey of Ireland; Author of "Aids in Practical Geology", &c.
G. B.	**Gerald Bloxsome**, M.R.C.V.S., Hospital for Nurses and Dogs, Hove.
G. M.	**G. Mayall**, Veterinary Surgeon, Norwich.
H. D. R.	**Henry Droop Richmond**, F.I.C., Aylesbury Dairy Co.; Author of "Dairy Chemistry".
H. L.	**Harold Leeney**, M.R.C.V.S., Author of "Home Doctoring of Animals", "The Lambing Pen", &c.

H. S. H. P.	**H. S. Holmes Pegler**, Secretary of the British Goat Society; Author of "The Book of the Goat".
H. W.	**Herbert Wright**, A.R.C.S., F.L.S., Consulting Economic Botanist; Author of "Rubber Cultivation in the British Empire", "Theobroma Cocoa", &c.
J. A. T.	**J. Arthur Thomson**, M.A., Professor of Natural History, Aberdeen University, Examiner in Agricultural Zoology for the National Diploma in Agriculture; Author of "Outlines of Zoology", "The Study of Animal Life", &c.
J. B.	**John Brown**, B.Sc., N.D.A., the West of Scotland Agricultural College, Glasgow.
J. Ca.	**James Cameron**, Agricultural Editor of the *Glasgow Herald*.
J. C. E.	**J. Cossar Ewart**, M.D., F.R.S., Regius Professor of Natural History, Edinburgh University; Author of "The Penycuik Experiments", &c.
J. G.	**The Very Rev. John Gillespie**, LL.D , Secretary of the Galloway Cattle Society, Ex-Chairman of the Directors of the Highland and Agricultural Society.
J. H.	**James Hendrick**, B.Sc., F.I.C., F.C.S., Lecturer in Agricultural Chemistry in the Aberdeen University, Chemist to the Highland and Agricultural Society of Scotland, Analyst to the Counties of Aberdeen, Banff, and Nairn.
J. N.	**John Nisbet**, D.Œc., Editor of "The Forester", "Studies in Forestry", "British Forest Trees", &c.
J. O. P.	**John O. Peet**, B.Sc., Agricultural Instructor, Hereford County Council; Joint Author of "Farm Bookkeeping".
J. P.	**Professor John Percival**, M.A.(Cantab.), F.L.S., Director of the Agricultural Department, University College, Reading; Author of "Agricultural Botany".
J. R.	**J. Rennie**, D.Sc., Natural History Department, Aberdeen University.
J. S.	**John Speir**, Newton Farm, near Glasgow, Member of the Royal Commission on Tuberculosis, 1897.
J. St.	**John Struthers**, M.A., B.Sc., formerly Lecturer on Agriculture, West of Scotland Agricultural College.
J. Wh.	**James Whitton**, Superintendent of Parks, Glasgow.
P. M'C.	**Primrose M'Connell**, B.Sc., F.G.S., Author of "Notebook of Agricultural Facts and Figures", "Elements of Farming", &c.
R. A. B.	**Reginald A. Berry**, F.I.C., F.C.S., Professor of Agricultural Chemistry in the West of Scotland Agricultural College; Joint Author of "Soil Analysis", "Selection of Seed by Chemical Methods", &c.
R. H.	**Richard Henderson**, Lecturer on Surveying in the West of Scotland Agricultural College; Author of "The Young Estate Manager's Guide", "The Modern Homestead", &c.

R. I. P.	**R. I. Pocock**, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens, Regent's Park, London.
R. M'C.	**Rev. R. M'Clelland**, Lecturer on Bee-keeping, West of Scotland Agricultural College.
R. P. W.	**R. Patrick Wright**, F.H.A.S., F.R.S.E., Principal of the West of Scotland Agricultural College; Author of "The Influence of Phosphates on Farm Crops", &c.
T. H.	**T. Hallissy**, B.A., of the Laboratory for the Investigation of Soils, Geological Survey of Ireland.
W. E. B.	**W. E. Bear**, formerly Editor of *Mark Lane Express.*
W. G. S.	**William G. Smith**, B.Sc., Ph.D., Lecturer in Agricultural Botany, University of Leeds; Translator of Tubeuf's "Diseases of Plants".
W. S. B.	**Wilfred Scawen Blunt**, Crabbet Arabian Stud, Southwater.
W. W.	**William Watson**, A.L.S., Curator, Royal Gardens, Kew; Editor of "The Gardener's Assistant".

The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald, and bear the initials of J. C. and F. V. T.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

Abatement.

1. INCOME TAX.—A person whose income falls below the sums specified in the statute is entitled to relief or abatement of the tax. See INCOME TAX.

2. RENT.—Where, under the powers reserved to the landlord in a lease to resume land for planting, feuing, or excambing, &c., or where, by inevitable accident, the tenant has been evicted from part of the subjects let, there will arise a claim for abatement of rent; in some cases the right to abandon the lease will emerge. See LEASE.

Abattoir, a name for a public slaughter-house, borrowed from the French. See SLAUGHTER-HOUSE.

A B C System of Sewage.—A method adopted for the purification of sewage in which alumina, blood, and charcoal are employed for the separation of the solid excreta and the purification of the liquid. See article on SEWAGE.

Abele, a name for the White Poplar tree. See POPLAR.

Aberdeen-Angus Cattle.—Old family histories and local records of a varied and fragmentary order do not help us much in tracing the origin of the polled cattle of Aberdeen and Angus. Whether the 'dodded' or 'hum'led' stock of Buchan and the Braes of Angus were set on their course independently as 'sports' from the horned animals of the two districts, or whether they had one common origin, is a matter of conjecture. In the early decades of the past century, men of Aberdeen and Angus had their warm disputes on the dual and single foundation pleas, but they never contrived to throw any valuable light on the matters at issue. Like the dancers in 'Sweet Auburn' they often delighted to tire each other down. There is ample evidence to show that the 'Humlies' of Buchan and the 'Doddies' of Angus were distinct breeds or varieties of one breed during the latter half of the 18th century. The late Mr. Thomas Smith, Powrie, the noted breeder of polled cattle, who was born in 1826, was wont to say that the Doddies of his native county were appreciated in his grandfather's time. The late Earl of Southesk, whose first magnificent herd of Angus cattle, founded on very old Forfarshire blood, was extinguished by rinderpest in 1865, could not fix upon the remote ancestor who had first started to keep polled cattle. A so-termed comparatively short-pedigreed strain in the herd of Mr. Patrick Chalmers of Aldbar traces back to a race of polled animals kept in the family dairy during the closing decades of the 18th century. References to 'black cattle' in old writings are of no guiding value in leading us to the origin of the polled stocks, because 'black' or 'horned' was employed for the purpose of grouping the bovine races apart from the horses, which also came under the common designation of 'cattle'. In their History of Polled Cattle, Macdonald and Sinclair quote from an old account book, belonging to G. B. Simpson, Broughty Ferry. Particulars are there given of certain cattle transactions conducted by the laird of Balmuir and district. In the book the earliest reference to polled cattle is dated 1752, 'one humble oax from James Cramond' being set down as having cost 30 pounds Scots. Later on, in 1757, references are made to a two-year-old quach (quey or heifer) doded, and to '10 oxen in the plew, 2 dodeds'. The native breed of hum'led cattle in the Buchan and neighbouring districts of Aberdeenshire was highly esteemed as far back as 1770, but whether the low-ground strains which then formed a large proportion of the dealers' droves were as pure as the smaller humlies of the uplands and glens is open to doubt. The probability is that the larger framed animals had been crossed more or less with the now extinct black and horned Fifeshire breed. In any case the polled animals which conformed most to the older standard had the greater amount of favour from the best native judges because they were much more easily fed, more hardy, and better killers than were the direct crosses of the cattle introduced from Fife and the north of England. Galloway cattle were taken into Aberdeenshire towards the end of the 18th century and for years afterwards, and crossed with the native humlies as well as with the horned stocks. The result was an increase in the polled totals of the North-East; but so far as one can judge from scraps of documentary evidence and oral testimony handed down from father to son, the unmixed animals of Buchan and neighbourhood had the advantage as general purpose and feeders' animals. About the same time an enterprising Forfarshire proprietor, Lord Panmure, conducted fairly extensive experiments with Galloway bulls, but with somewhat disappointing results as judged by the county standard. The late

William M'Combie of Tillyfour subjected Galloway blood to repeated tests, until he came to the definite conclusion that the cross was the means of 'slowing down' the rate of feeding. His contemporary and friend, Alexander Bowie, Mains of Kelly, Arbroath, took extraordinary pains to secure the best of the pure strains of Angus. Unless a Polled Angus animal had a little white on its underline and grey hairs in the tail, he would not have it on any account, as he held that the all-black raised suspicions of Galloway blood.

Although Buchan Humlies and Angus Doddies are of unknown antiquity, it must not be supposed that horns or 'scurs' were uncommon in strains which were held to be quite pure. During the earlier decades of the 19th century many breeders were more concerned about the milking and feeding properties of the Aberdeen and Angus cattle than with perfection of polled character. A small minority of careful breeders had a dislike to 'scurs' or abortive horns, but they would never dream of discarding a good bull or cow because it had such. The 19th century indeed was four-fifths on its way before an approach to a dead-set was made against 'scurs'. Possibly the last of the distinguished animals with 'side ornaments' which took first position at the Highland Society was the Tillyfour-bred Shah (680), which won for the late Mr. Thomas Ferguson at Dumfries in 1878. Even a loose 'scur', which the best of the old breeders always tolerated or regarded as harmless in the transmissible sense, is now sufficient to relegate an animal to the non-breeding ranks or to the sphere of cross-breds.

Black, with or without a slight touch of white on the udder or scrotum, and grey hairs in the tail, is now the colour standard; but the best cattle should begin life with a 'mousy-brown' coat of hair, and at no time should an inky tinge predominate. Jet-black is frequently associated with hard hair, a stiff skin, and slow feeding. The Americans, who made extensive purchases of Aberdeen-Angus cattle in the 'seventies and early 'eighties of the past century, have been largely responsible for elimination of white. In the early decades of the 19th century the polled cattle of Aberdeen and Angus were black-and-white, brown, yellow-red, brindled, and occasionally grey and dun. The fathers of the oldest agriculturists now in Angus were very fond of white underlines and grey tails, and some of them liked to see a few 'belted' animals in every herd.

The first great improver of Angus cattle was Hugh Watson (1789–1865), who became tenant of the large holding of Keillor, near Newtyle, in 1808. On entering Keillor he received from his father six of the 'best and blackest cows' along with a bull to found a polled herd; but the young man was not satisfied with these, as he very soon discarded them for the ten best heifers and the best bull he could procure at Trinity Muir Market, Brechin. Working from that base, and making a few careful selections as opportunity offered, Watson resolutely took up the task of improving the breed by putting the best to the best, and by severely discarding animals which did not conform to his standard. A friend of the most distinguished of English Shorthorn breeders, he had liberal tastes, remarkable keenness of observation, and wonderful genius in selecting his materials. It is known that he had the most perfect of Shorthorn types in view when moulding his polled stock; and in seeking greater length and depth of quarters he was wont to acknowledge a measure of indebtedness to the Booth model. All the Aberdeen-Angus world to-day is deeply indebted to Keillor. Watson's enthusiastic pupil, Thomas Ferguson, Kinochtry; the accomplished Alexander Bowie; the poetic naturalist, the late Earl of Southesk; William Fullerton, Ardestie; Scott, Balwyllo; the Mustards of Leuchland and Fithie; the Whytes of Braedownie and Spott; Robert Walker, Portlethen; Walker, Montbletton; Paterson, Mulben; the Skinners, Drumin; Sir George Macpherson Grant, Bart.; Hannay, Gavenwood; Brown, Westertown, and many others took up the polled cause with great enterprise and success, once the tide was fairly set towards improvement and conquest. In Aberdeenshire the pre-eminent man in the ranks of those who sought to evolve a higher type of polled cattle was William M'Combie (1805–1880), a man of great natural ability, force of character, and breadth of mind in matters of breed evolution. If men like Watson, Bowie, Fullerton, Lord Southesk, and Robert Walker prepared some of the great materials, M'Combie seized upon them with unparalleled sagacity, worked them up afresh, and made the polled breed the admiration of the world by his brilliant victories at the breeding and fat-stock exhibitions. At the Paris Exhibitions of 1856, 1862, and 1878, and at Poissy in 1857, M'Combie drew the world's attention to the merits of Aberdeen and Angus cattle. At the earliest of those exhibitions he had two firsts out of six classes for polled steers, also a second and a third, two gold medals, a silver and a bronze medal. The herd-triumph of his lifetime was obtained at Paris in 1878 when he secured the two £100 champion prizes, first for the best group of cattle foreign to France, and second for the best group of beef-producing animals in the exhibition. The Tillyfour group was composed of the cow Gaily (1793), the four heifers Sybil 2nd (3526), Halt 2nd (3527), Pride of Aberdeen 9th (3253), and Witch of Endor (3528), and the yearling bull Paris (1473). The late Sir George Macpherson Grant, Bart. (1839–1907), the acknowledged 'chief' of the Aberdeen-Angus world after M'Combie's death, was reserve in both cases with animals of even more distinguished breeding if less uniform when viewed as a group. They were the cows Eisa (977) and Eva (984), the heifers Birthday (3373) and Maid of Avon (2995), the aged bull Judge (1150), and the yearling Petrarch (1258). M'Combie's most notable steer at the great fat-stock exhibitions was Black Prince, which as a four-year-old carried off all the honours at Birmingham and Smithfield in 1867, and was then, by express desire, forwarded to Windsor for Queen Victoria's inspection.

The first volume of the Polled Herd Book was issued in 1862 under peculiar difficulties. Edward Ravenscroft began to collect materials for a foundation volume in the early 'forties of the century, but his great collection of notes was destroyed in 1851 by a fire which broke out in the museum of the Highland Society, Edinburgh. It is practically needless to say that the matter which was more hurriedly secured the second time contained many inaccuracies. The second volume was not issued until 1872, the joint-editors being Mr. Alexander (afterwards Dr.) Ramsay, Banff, and Mr. H. D. Adamson, formerly of Balquharn, Alford. From that stage, registration had continuous attention. The first four volumes registered Galloway cattle along with the Aberdeen and Angus; but before the fifth was issued, the Galloway Cattle Society 'hived off' after acquiring the copyright of the sections which dealt with their own breed. In 1879 the breeders of the North-East established the Polled Cattle Society, and at that date it was resolved to discontinue the terms 'Aberdeen or Angus' and 'Aberdeen and Angus' and to close the ranks under the name of Aberdeen-Angus.

The frankest admirers of Aberdeen-Angus cattle admit that the breed has hitherto lacked uniformity of character, but that defect is steadily disappearing through the more general use of line-bred sires from first-rank herds which are themselves more or less closely allied in blood. Of the all-conquering families, the Ericas and the Prides of Aberdeen may be said to head the lists. The first Erica—entered as 843 in the Herd Book—was bred by the late Earl of Southesk, and calved in 1857. At the Kinnaird sale in October, 1861, she passed into the possession of Sir George Macpherson Grant at 50 guineas. She was a cow of beautiful feminine character and great quality, but was a little slack in her back. Her sire was the great Mains of Kelly show bull Cupbearer (59), and her dam was Emily (332), a daughter of the cow Beauty, bred by Hugh Watson. At Ballindalloch the Ericas have been extraordinarily successful as breeding and showyard animals. The favourite branch of the family is the one with the cross of M'Combie's famous bull Trojan (402), which was secured by Sir George in 1865 for 50 guineas. Trojan was by Black Prince of Tillyfour (366), and his dam was Charlotte (203), the gold-medal cow at Paris in 1856 and mother of the first Pride of Aberdeen. Black Prince again was a grandson of the Mains of Kelly Hanton (228), also a gold-medal winner at the French Exhibition. A daughter of the first Erica by the Ballindalloch Kildonan (405) has founded a strain which has not somehow 'caught on', as have the representatives of the beautiful Trojan cows Eisa (977) and Enchantress (981). The Prides of Aberdeen, struck off by M'Combie, are descended from a yearling heifer which he named Queen Mother (348). He bought her at William Fullerton's Ardovie sale in 1844. She was by the noted bull Panmure (51), and her dam was Queen of Ardovie (29). At Tillyfour Queen Mother bred the females Lola Montez (208), Bloomer (201), and Windsor (202). Passing into the possession of Alexander Bowie, she then left Victoria of Kelly (345). Putting Queen Mother to Monarch (44), bred by Fullerton, M'Combie had Lola Montez and Bloomer. This was working with close affinities, as Monarch was by Panmure (51) out of a cow by the same sire. Queen Mother was next mated with Victor (46), a son of Monarch out of a full sister of Queen Mother—this being closer breeding still—and the result was the very fine cow Windsor, one of the best at Tillyfour. M'Combie then sought an outcross for his much in-bred daughters of Queen Mother, and his choice in 1848 was the grand Keillor bull Angus (45), which he used for several seasons. He was the sire of Charlotte (203) out of Lola Montez, and Beauty of Morlich (2072) out of Windsor. Angus was succeeded by the noted show bull Hanton (228), bred at Mains of Kelly, and this sire introduced once again a moderate infusion of Panmure blood. His one fault was a pair of loose 'scurs'. At Tillyfour his most famous daughters were out of Charlotte, these being Pride of Aberdeen (581)—the wonder of her time as prize-winner and breeder—Empress of France (578), and Daisy of Tillyfour (1165), the foundress of another well-known family. The Victoria of Kelly and Duchess of Westertown branches of the Queen Mother family have also been held in high favour. Other notable Aberdeen-Angus families are the Jilts, so renowned through the successes of the Ballindalloch bulls Judge, Juryman, and Justice; the Ruths of Tillyfour, from the same Keillor foundation; the Miss Burgesses, descended from a cow owned by the tenant of Slack Farm, near Ballindalloch; the Montbletton Mayflowers, from which have sprung the world-famed Lady Idas, and the Blackbirds so esteemed in America, the transatlantic favourites being from Lady Ida's daughter Blackbird of Corskie. The Mayflowers themselves are from the old Forfarshire Lady Craigo (99), which was named after her birthplace. From her again we have through another line the Brides with which Mr. Clement Stephenson has done so well. The Easter Tulloch Mayflowers, a grand strain descended from the late Robert Walker's Old Maggie of Portlethen (681), had the credit of producing the Witches of Endor and the Mays of Powrie. M'Combie bought the mother of his 'Paris Witch' from James Scott, Easter Tulloch. At the Tillyfour dispersion the member of the Paris group passed to Lord Tweedmouth, and the mother went to Powrie, where she produced Witch of Endor 2nd. James Scott had fame also, and a fair share of fortune, with the prolific Ruby family, descended from the Kinnaird Old Lady Ann (743), and notable in after-years at Powrie. Other families of repute are the Beautys of Garline, so much associated with Glamis and Hayston; the Coquettes, from the late Sir John Macpherson Grant's Dandy (794); the Roses of Westertown, from Blinkbonny (315), bred at Ardgay; the two distinct Matildas, of Waterside and Cortachy reputation, the latter strain having its foundation at The Burn; the Heather Blossoms, directly sprung from Heather Bell of Rothiemay, and now strongly fancied in America under the old name of Heather Blooms; the

Advie Roses, of Ballindalloch origin; the Nosegays, from the same source; the Portlethen Lucys, from Robert Walker's Brown Mouth (665), and with a good offset at Drumin; the Kinochtry Princesses, from the Keillor Old Grannie (1); the Lady Fannys, descended from the north country Grannie (131); the Sybils of Bogfern with their vigorous branch the Fred's Darlings; the Spott Jipseys; the Georginas of Burnside and Rothiemay, the former from Susan of Burnside (166), the latter from Old Lady Jean (187); the Cortachy Ariadnes, from which sprung the Dalmore Attractions; the Aldbar Maggies, of very old Angus breeding; and the Mulben Mayflowers, from Alexander Paterson's Madge (161).

In M'Combie's later years the fashion of breeding the Aberdeen-Angus almost exclusively for beef production had attained a fairly strong ascendency, but there were protests from many who wished to retain the general purpose and dairying qualities of the black polls. At Cortachy, the Guynd, Aldbar, Cullen House, and other places, it was demonstrated that the Aberdeen-Angus was a front-rank breed at the dairy for a combination of quantity and quality of milk. Still, the advocates of beef had the better of their opponents during the 'eighties and 'nineties of the past century, but since then there has been a moderate reaction. The utmost has been made of beefy tendencies, but more attention has been paid to the milking qualities. Cattle of rather finer moulding than those favoured by a good many of the old breeders came in gradually as the old century was passing away, and with the new era the danger of over-closeness in build, or a certain lack of length and liberty, has to be guarded against by some breeders in the old haunts of the polled race.

The modern Aberdeen-Angus should have a neat and distinct but not high poll. The ears should be set on at the most pleasing artistic pitch; they should be fine at the junction with the head, fairly long, shell-like in curve at the rounding off, and carried with great gaiety. Low-set, heavy, sluggish ears were often seen on some bygone heads. In a fed animal the neck-vein and brisket should be rounded and full, the crops in the male should be of medium width, and well covered with muscular flesh; the back, loin, hook or hip bones, and quarters should look as much as possible like 'one piece' or should merge with the utmost smoothness into each other. Square hook bones like those of the Shorthorn are not a family trait with the genuine Angus. The length from the top line midway between the hooks and the setting on of the tail should be good, but the finish of the quarters as viewed aloft ought not to be quite on the square. Rounds and thighs ought to be well filled. A rapid curving in of the lower thigh so as to give a 'piggy' appearance is not desirable. Although a straight underline like that of the Shorthorn is not one of the old characteristics of the polled breed, freedom from paunchiness has always been aimed at in a reasonable way. Further, the modern Aberdeen-Angus should stand on flat, refined bones, the hock joints being moderately 'set' or bent; the skin should be of fair thickness. In winter the animal should have a coat and vest—a thick and comparatively soft outer covering with a furry growth below which looks fluffy and brownish in early summer when the outer hair is cast. The tail of a well-bred animal comes to a fine point, and the hair on it is not coarse or harsh. The carriage of the best animals should be jaunty and gay, the eyes and ears having an alert, lively expression. In the main the points of the breed as given in the thirteenth volume of the Herd Book have been adhered to with a fair degree of closeness. It falls to be said, however, that although a half white udder is never condemned by a good judge, only the slightest touch of white is tolerated on the scrotum of a bull.

During the three closing decades of the nineteenth century the breed had a spreading over most parts of the world. At the present time its strongholds are the United Kingdom, and the Northern States of America, and Canada, but considerable herds are to be found in South America, while Australia, New Zealand, Tasmania, South Africa, the West Indies, and the Continent of Europe have their fairly large totals of the breed. At home and abroad the breed has been phenomenally successful at the fat-stock shows and carcass competitions alike in pure and graded forms. In America the Angus crosses are known as 'market toppers'. All over the United Kingdom the black and blue grey crosses—results of Aberdeen-Angus and Shorthorn blending—are supremely popular in the ordinary fat-stock markets. In the London Christmas market the term 'prime Scots' has been specially applied to the polled crosses of the Scottish North-East since the M'Combie days, but the modern blacks have practically gained a year in the matter of early maturity. Pure-bred Aberdeen-Angus steers of the first rank are never very plentiful because of the demand for bulls of a superior order; but at such exhibitions as the Birmingham and Smithfield in early December, steers of the breed are always in or near the final when specials for best male animals are being decided.

Since 1869, when the champion plate for best beast in the show was first awarded at Smithfield, eleven pure Aberdeen-Angus animals and two of the Shorthorn and Aberdeen-Angus cross have won. The breed has further supplied the female champion of the show sixteen times out of the thirty-seven years. In twelve years during which the late Queen Victoria's and His Majesty the King's challenge cups have been granted for best beast in the show bred by exhibitor, the win has gone seven times to an Aberdeen-Angus, once to a Shorthorn-Aberdeen-Angus, and once to an Aberdeen-Angus-Shorthorn cross. At the 1907 carcass competition in connection with the Smithfield Show, the Aberdeen-Angus took first and championship, the breed having also two seconds, while a first and two fourths fell to Aberdeen-Angus-Shorthorn crosses, and a third to a Galloway-Aberdeen-Angus cross. It is worthy of note that an Aberdeen-Angus heifer which won second against a Sussex and Shorthorn cross fetched 6*s.* per stone against 5*s.* 2*d.* made by the first. It is unnecessary to go into details of bygone winnings at the carcass competition further than to state that the Butchers' Company Challenge Cup, first granted in 1904, for best carcass of beef has gone twice to Aberdeen-Angus-Shorthorn crosses, once to a cross of the reverse order, and once to a pure Aberdeen-Angus. With reference to the average weights of the Aberdeen-Angus stock shown in the regular classes at Smithfield, the figures for the show of 1907 may be taken as a fair return. Seven steers under two years old ranged from 12 cwt. 20 lb. to 14 cwt. 12 lb.—average, 12 cwt. 104 lb. Five steers under three years had a range from 16 cwt. 28 lb. to 18 cwt. 3 lb.—average, 17 cwt. 12 lb. Six heifers under three years weighed from 13 cwt. 42 lb. to 16 cwt. 5 lb.—average, 14 cwt. 80 lb. In America, Aberdeen-Angus animals have headed the Chicago beef market for twenty years in succession when forwarded as car lots, and the championships of the breed and its grades in the States and Canada would be difficult to recount. At eight of the Chicago International Exhibitions alone an Aberdeen-Angus has carried off the championship thrice, a grade of the breed once, and at the other four shows a high-grade animal of the breed has stood as reserve champion. Further, in the competition for car lots, the championship has gone to Angus grades six times out of eight tests.

The question may be asked, What are the average weights of mature Aberdeen-Angus animals exhibited at the home summer shows as breeding stock? Maramere, which may be taken as an example, weighed 23 cwt. 40 lb. when three years and eight months old. His four-year-old son, Idelamere, the male champion of 1907 at the English Royal and the Highland Society, turned the scales at fully 20 cwt. 28 lb. when exhibited at the former show, and his weight may be taken as about the modern standard for a male animal of the breed over three and a half years, and sent into the ring in fit condition. Bartonia of Glamis, the female champion at the Edinburgh Highland, was a few pounds over 17 cwt. when exhibited, but in these days a return of 15 cwt. is reckoned quite enough for a well-shown four- or five-year-old cow of the breed with calf at foot. Great weight in moderate bulk is a characteristic of the breed. An old saying in the home of the polls has it that a genuine blackskin 'weighs like a stone'. A further important recommendation is that the breed is very easily summered and wintered.

When a general meeting of the Polled Cattle Society was first held in 1880 the membership was 56. The membership limit at that stage was 500; but in 1901 it was considered advisable to double the original limit. The thirty-first volume of the Herd Book, issued in 1907, showed that the Society had 512 members—285 in Scotland, 120 in England, 71 in Ireland, and 26 in foreign and colonial countries. The volume to which reference is now made shows that 67,998 animals have been registered—26,499 bulls and 41,499 females. The late Duke of Richmond was probably the first to found a herd of Aberdeen-Angus cattle in England, as he bought a number of animals in 1874 for his home farm at Goodwood, Surrey. Mr. Carter Wood, Great Grinstead, and the Duke of Grafton followed, but the oldest herd in England at the present time is that owned by Mr. J. H. Bridges, of Langshott, in Surrey. Mr. Bridges, who founded his herd in 1876, had early experience of the breed while learning farming on his property of Fedderate, in Aberdeenshire. Since that time he and his enthusiastic agent, Mr. Albert Pulling, have done a very great deal for the blackskins in the south of England. In due course such Englishmen as Mr. Arthur Egginton, South Ella, Hull; Mr. Owen C. Wallis, of Bradley Hall; Mr. Clement Stephenson, F.R.C.V.S., Balliol College Farm, Newcastle-on-Tyne; Major Dent, Northallerton; Rev. Chas. Bolden, Preston Bisset, Bucks; Mr. W. B. Greenfield, of Haynes Park, Beds; Mr. J. M'Intyre of Theakston; Mr. J. J. Cridlan, of Maisemore Park, Gloucester; Mr. C. W. Schroeter; Messrs. Casswell; Mr. T. H. Bainbridge, of Eshott, Northumberland; Sir George Cooper, Bart., of Hursley Park, Hants, and many others, fell into the polled ranks. South of the Border, whole-hearted work on behalf of the breed has been done by owners of pure-bred herds, and men engaged in the grazing and feeding of black polled crosses. Outside Scotland no one has done so much for the Aberdeen-Angus as Mr. Clement Stephenson. His remarkable list of winners at Birmingham, Smithfield, and other fat-stock shows, headed by the magnificent heifers Luxury,—which gave a carcass return of 75 per cent—Young Bellona, and Benton Bride, attracted the attention of the whole stock-owning world. Mr. Stephenson drove home the lesson that the blacks are cosmopolitan. The English Aberdeen-Angus Association now looks well after the interests of the breed south of the Border.

Aberdeen-Angus bulls were sent to Ireland during the 'forties and 'fifties of the past century, the earliest, so far as recorded, being from Keillor; but the first systematic attempt to found a herd was made in 1864, when Sir Chas. Knox-Gore purchased a bull and a few females. In 1876, however, there were only three or four herds of the breed in Ireland, but from that year onwards through the 'eighties Irish recruits for the polled interest, headed by such men as the Earl of Longford, Capt. Anketell-Jones, Lord Castletown, Major Cane, Messrs. Owen, Nash, MacGloin, Bland, and Coey, were readily found. An Irish Association now pays close attention to matters affecting the black polls in the West. Men who have watched the progress of Aberdeen-Angus cattle in and beyond the Scottish North-East are inclined to think that the close and smooth knitting of frame seen on the typical lands of Angus and Aberdeen is to some extent lost in parts of southern England and the richer sections of Ireland, but the tendency towards greater openness of carcass—the outcome of peculiar forces at command of soil and climate—is carefully studied and successfully met by the best breeders.

So far as can be traced, not a single Aberdeen-Angus animal was to be found in North America previous to 1873, and to Professor Brown of the Ontario Agricultural College belongs the credit of founding the first transatlantic herd with a bull and two female animals. That was in 1876. Mr. Brown, who had previously been agent on the Invercauld estate, Aberdeenshire, was friendly adviser to many in the Northern States and Canada who wished to give the black-skins a trial, and the fine animals which he took out directly or recommended to others had the effect of creating an extraordinary demand, especially from about 1879 to 1885. An American Aberdeen-Angus Association was formed in 1883. That body, which has now a membership of about 1000, has issued sixteen volumes of a Herd Book. The total head of stock now registered reaches 100,500. Among the early importers of Aberdeen-Angus cattle to North America were the Honourable J. H. Pope, Canadian Minister of Agriculture; Mr. Whitfield, Quebec, who took out the great Jilt bulls Judge and Justice; Mr. Cochrane, of Hillhurst, whose name is so intimately associated with shorthorn matters through the Bates Duchesses; Messrs. Geary, Ontario; Anderson & Findlay, Illinois; Gudgell & Simpson, Missouri; Henry & Matthews, Kansas; Estill & Elliot, of the same State; and Mr. Redfield, Batavia, New York. When the boom was at its height, prices were mere incidentals to the men of the great Republic and their friends in Canada. As an instance it may be stated that the late Mr. Thos. Ferguson, Kinochtry, sold all his heifer calves of the Princess family at 60 gs. each to one American for two or three seasons, a year in advance, or before the animals were born. After 1885 American demand for Aberdeen-Angus cattle gradually fell away, and it became practically non-existent in the early 'nineties. Great injury was no doubt caused by the exporting of inferior animals.

Within the past six years the States and Canada have selected fair numbers of polled cattle from this country, but the hope of the near future may be said to rest on the great stock-raising countries, Argentina, Chile, and Uruguay, where the Aberdeen-Angus and their crosses are rapidly coming into favour. The secretary of the Polled Cattle Society gives the total exports of the breed for the past three years as follows: 48 in 1905, 180 in 1906, and 76 in 1907. [J. Ca.]

Abies, the botanic name for the fir genus of trees. See Fir.

Ablactation (= weaning).—A scientific term used to denote the cessation of the functional activity of the mammary glands when the offspring of any animal is being weaned from its parent. It is occasionally applied by veterinary surgeons with reference to farm animals.

Abomasum.—The abomasum is the true digestive stomach of ruminants, and is commonly known as the fourth stomach. It lies to the right of the front and lower central parts of the rumen or paunch, also called the first stomach. See Stomach. [H. L.]

Abortion.—The expulsion of the fruit of conception (fœtus) from the uterus or womb before it is capable of living apart from the mother is called abortion. At a time when sociologists in many civilized countries are concerned about a declining birth-rate, it is comforting to farmers and stock-owners to know that the same considerations and conditions which operate in the decrease of human population are not prevalent in the case of the domesticated animals.

Stock to the farmer is as good as money, and fortunately, with few exceptions, the fruits of conception in the domesticated animals usually come to uterine maturity. One of the annoying and unsatisfactory things the breeder of stock has to contend with, however, is this subject of abortion. Even in single instances and in its accidental form, its occurrence occasions disappointment and monetary loss; whilst in its epizootic or contagious form, abortion is a matter of great seriousness. In the State of New York the money loss from this complaint alone has been said to be 4,000,000 dollars annually.

The mare is not such a frequent subject of the mishap as the cow, and with her it frequently takes place in the first half of pregnancy. Ewes, next to cows, most frequently abort, and perhaps sows and bitches are the least liable to this complaint.

Sporadic or accidental abortion is liable to occur in any animal from varied causes. The chief are blows (through being horned or kicked), falls, overexertion, railway journeys when pregnant in the case of cattle, unsuitable food such as decaying or frozen roots or cabbages, bad smells, drastic purgatives, cold wet weather and insufficient food, plethora and too rich food, and drinking iced water. One frequent cause of abortion is that the mother catches influenza or some blood disease such as septicæmia or pyæmia when pregnant. Continued coughing has been said to produce it. Any disease accompanied by a high temperature will bring it on. Metallic poisons such as arsenic may occasion it. Vegetable poisons may also produce it, and cases have been recorded where the animal has picked up some poisonous plant while grazing, such as aconite or the poisonous buttercup *Ranunculus acris*. Fright may occasion abortion, *e.g.* the chasing of pregnant ewes by a dog, but overexertion also comes in here as a cause. There is a tendency for one abortion to be followed by another in a herd where animals in the open crowd round one of their mates and witness the act in her. Exploration *per vaginam* by the laity with dirty hands and arms has been noticed to hasten this accident if not to produce it.

To understand the subject of abortion it will be necessary to touch on the parts concerned in the matter. Roughly and directly these are: the vulva, the vagina, and the womb or uterus and its contents. The vulva or shape is situated externally, and from it a passage called the vagina (which receives the male organ at the time of copulation) extends to the mouth of the womb or os uteri, the latter extending into the end of the vagina, in shape like the top end of a bottle. From the os uteri the womb in pregnancy bellies out into the cavities of the pelvis and abdomen, and is a pear-shaped structure with three soft coats, a serous, muscular, and mucous. Inside the uterus the envelopes surrounding the fœtus are superposed and attached to the vagina at the neck of the uterus. They are called, from without to within, the allantois, the chorion, and the amnion. The amnion contains a liquid in which the fœtus is suspended and floats. This liquid is one of the provisions of Providence to enable the fœtus to grow and expand, to protect the mother from injuries by the fœtus towards the termination of pregnancy, to preserve fœtal life from external violence, and to aid, at the time of parturition, the lubricating of the vagina for the passage of the young into the world.

Symptoms.—There are frequently no warning symptoms. The act may occur in the night, and the immature fruit be found lying behind the mother enclosed in its envelopes, or it may occur in the field, and not be noticed at all, especially if the fœtus be only 4 or 5 in. long. This is often the case when abortion takes place early in pregnancy. Later on, the amnion ruptures and the fœtus escapes, and the envelopes may be retained, and have to be, especially in cattle, manually removed by a veterinary surgeon after much trouble. If the abortion is due to a severe injury or disease, serious and sudden complications may arise, and the mother may quickly expire. Probably here the accident does not happen without warning, but notwithstanding the most careful preparation and attention, death of the mother occurs. If the fœtus is dead in the womb—a not uncommon occurrence in abortion—a fœtid, discoloured, or purulent fluid escapes from the vagina and vulva prior to its expulsion.

Treatment.—This is preventive and remedial.

If the animal is noticed showing signs of abortion, such as straining and uneasiness, or there is the history of an accident, or in other words if help is early on the scene, and circumstances show it may be wise to prevent the act, or that there is a good chance of preventing it, a soothing sedative draught of chloral (half an ounce to a mare in eight ounces of water, and an ounce to a cow in a pint of water) may be given. This, combined with quietude and getting the animal into a loose box or shed by herself, may avert the catastrophe. Frequently, however, the worst happens, and the mother should at once be isolated and attended to.

Abortion having occurred, the fœtus and its envelopes should be burnt or buried. If the envelopes are retained—a common occurrence in the late periods of abortion—they should be removed as soon as possible, observing like sanitary precautions.

The vagina and womb should be well syringed out with an antiseptic, such as creolin (a wineglassful to a bucketful of warm water); the tail, perineal region, back of the udder and inside the thighs, especially in milking cattle, should be well washed with the same germicide; and the floor of the dwelling kept clean and swilled with a stronger solution of the disinfectant, or sprinkled with carbolic powder.

Warm fluids, such as linseed tea, oatmeal gruel, or bran tea, should be given the mother to drink, or plenty of water. The animal, if a cow, should be sold, or not bred from the following year. The same principles should be observed in ewes and sows, especially as regards early isolation and burning or burying of the fœtus and its envelopes.

From what has already been written, it will be gathered that *contagious or epizootic abortion* is a very serious disease. It may be described, when it occurs, as a veritable plague. Happening in a stud of mares, a herd of cows, or a flock of ewes, it will occasion great loss to the farmer and stock-breeder, and much anxiety and trouble before it is overcome. It has been the subject of investigation among prominent veterinarians of most European countries for many years. The Danes, the French, the Germans, and the British have investigated its origin sedulously. *It has been the subject of enquiry by special* commissions in this country. Generally it has been agreed that it is a disease of a contagious nature, due to a spe[illegible] organism or bacillus. This bacillus may be transmitted by the tails, *dejecta*, litter, or attendants from one animal to another. The disease has been produced artificially by inserting matter, such as some of the discharge or a piece of the after-birth, from a subject aborting into that of the vagina of a pregnant animal. To occasion abortion this organism must gain entrance into the womb, which in a pregnant animal is an organ [illegible]tically sealed. The port of entry of the bacillus into the womb is generally by way of the vulva and vagina to the os uteri, and thence to the fœtal membranes and to the interior of the womb. Occasionally the abortion bacillus may be taken in by the respiratory or digestive organs, and gain entry to the womb by the blood stream. An infectious catarrh of the vagina has long been recognized by the Germans as occasioning abortion, and there is no doubt that the hygiene of the vagina should be well considered during pregnancy. Contagious abortion in cattle seldom occurs before the third or fourth month of pregnancy. In the mare it is generally from the fourth to the seventh month. The fœtus is generally dead. One abortion is followed by others at intervals, and the percentage among a number of animals becomes large, in some cases reaching 50 per cent. It usually occurs primarily where pregnant animals are bought into a stud or herd, and once started any animals sold from these and introduced among healthy pregnant cows or mares may communicate the disease. As the organism lives and flourishes in the vaginal and womb discharges, it will be easily seen by the practical farmer and stock-breeder that the bull or stallion may be the conveyer of the disease.

Symptoms of Epizootic Abortion.—Occasionally there may be no warning symptoms but slight uneasiness and a sudden expulsion of the fœtus. Frequently there is a reddening of the mucous membrane of the vagina, followed by pimple-like elevations and a reddish discharge. The milk may continue well up to the time of the mishap, or it may get thick and absent before the event.

The most important matter in the treatment of this complaint is a full and strict carrying out of *all the known laws of isolation and hygiene* as applied to the domesticated animals.

The animal aborting or about to abort should at once be removed to a separate dwelling or shed, preferably large and easily cleansable.

If she abort among her pregnant companions, the stall she has been in should be cleansed and swilled with disinfectant, and the channel behind her and the stall posts or bales washed with hot water and disinfectant. Inasmuch as the attendant, if he cannot be dispensed with, may convey the infection, he also should well look to his cleanliness before going in and out again among the pregnant animals. The stall in which the animal has aborted should be left empty.

Isolation accomplished, the fœtus and its envelopes should be burnt or buried in lime.

All pregnant animals should have their vulvas, tails, and thighs cleansed and sponged with disinfectant, and some say their vaginas irrigated with an antiseptic solution.

For the above purpose, preparations of mercuric chloride (corrosive sublimate) are perhaps the best.

Finlay Dun recommends irrigation of the vagina and washing the external genitals with 1 part of corrosive sublimate, 40 parts of common salt, and 4000 parts of clean rain water. There is no doubt that mercuric iodide is an excellent drug to use. Tablets can be bought with full directions how to make solutions. Inasmuch as some injections may produce irritation of the vaginal canal when frequently used, and thus bring on abortion in pregnant animals, soluble vaginal balls made with cacao butter and bacillol or chinosol have been used in Germany. These are inserted into the vagina with a clean hand and arm, and left there to dissolve.

In some cases it may not be possible to even isolate the aborting animals These should then be put in a row as they abort, and see that no pregnant subjects are on a lower level than the aborting animals are, so that any discharges from them may not come in contact with healthy pregnant animals. They should be cut off from the other animals as much as possible, and given a separate attendant and utensils.

Where contagious abortion exists, all newly-purchased pregnant animals should be placed by themselves for a time until parturition has occurred, and then they may be put among the healthy stock.

The attendant on animals aborting, or that have aborted, should be delegated specially to them. If possible he should on no account go in and out among the healthy pregnant animals, nor enter the building where they are. All fœtuses and their envelopes should be burnt or buried deeply in lime, preferably in some isolated spot not grazed on. The disease having come to an end, all cows or ewes should be sold. They are generally sterile afterwards. The buildings the animals have occupied should be stoved with sulphur by setting in the building several old vessels filled with a mixture of flowers of sulphur and methylated spirit, and setting this alight and keeping all openings closed for twenty-four hours. Afterwards the floors should be cleansed with hot water swilled with disinfectant (half a pint of creolin to a bucketful of hot water), and the walls lime-washed with carbolized whitewash (a quarter of a pint or more of crude carbolic acid to each bucket of whitewash). In the cleansing operations, stall posts and mangers should not be overlooked. Powdered lime may be strewn on the floor when it is dry. If the floor is of earth this may be dug up and resurfaced with soil mixed with chloride of lime.

This disease in two or three years is said naturally to die out, and possibly some artificial method of conferring immunity may be discovered in the future.

All dwellings that have been occupied by affected animals, after being thoroughly cleansed and disinfected, should be left empty for a time, and open to the four winds of heaven and the sunshine, if there be any.

It will be seen that it is rather a serious matter to attempt to breed from animals that have suffered from contagious abortion. *If one uses another man's sire, one may get into* serious trouble if the sire disseminates the complaint.

Not a few practical farmers have declared that they have had success in preventing abortion by what is known as the carbolic-acid treatment, the object aimed at being to saturate the cow's system more or less with the drug, and so render her unsuitable for the bacillus to dwell in. The method is to give 2 drachms of the pure acid in a pint of cold linseed gruel once a week, and gradually increase the dose until 4 drachms is reached.

The following precautions are recommended by Fleming to be adopted *in the case of ewes* suffering from contagious abortion. Labat successfully adopted these measures in France.

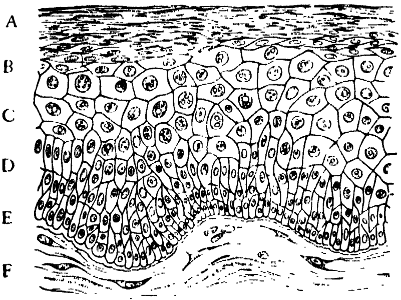
1. Evacuate the sheepfold.
2. Separate the pregnant ewes from those which have aborted.
3. Place the pregnant ewes in a clean, well-ventilated place.
4. Every week remove the dung: clean the floors, walls, and racks with boiling potash water.
5. Every ewe which aborts is to be immediately removed from the healthy group to the group that has aborted; replace soiled litter, and bury fœtus and membranes in lime in an out-of-the-way place.
6. Every morning sponge the vulva, anus, perinæum, and tail of the ewes with a solution of corrosive sublimate.
7. Feed on good food and avoid chills.

[G. M.]

Abraxas grossulariata (the Magpie or Currant Moth).—This is one of the Geometer moths; the larvæ are 'loopers'. The moths have wing expanse of about 2 inches; creamy white, spotted and banded with black and yellow, with thin bodies. They occur in July and August in gardens and plantations, flying towards dusk; their oblong, yellowish eggs are laid on currant, gooseberry, nut, and other leaves. The ova soon hatch, and the small dark caterpillars feed on the foliage until it is too hard, and then hibernate amongst dead leaves, under stones, sticks, &c. In spring they come out and feed upon the buds and young foliage, and do much harm. From mid June to early July they mature, and reach 1¼ in. long; colour creamy white, spotted and marked with black, and with orange spots at sides. They spin irregular, scanty cocoons amongst the leaves, &c., in which they change to black pupæ with yellow bands.

Treatment consists of destroying them in their winter quarters, and early spraying with arsenate of lead. [F. V. T.].

Abscess. — Abscesses or boils are of frequent occurrence in animals, and are of different kinds. External violence, or the introduction of foreign bodies, as thorns, stakes, stings, and the presence of parasites, as warbles, under the skin, account for the majority. An abscess is described as a circumscribed swelling containing pus, but there is a preliminary period of inflammation, during which the seat of injury is increasingly painful and tender to the touch. No period can be assigned for the development of an abscess, as it depends upon the depth at which matter is forming, and the kind of tissues through which it has to penetrate before reaching the surface. For examples, we may take the abscess found in a joint of meat when the drover has struck an animal a few days before it was slaughtered—a cavity with pus in it being already formed; and, on the other hand, the abscess known as poll evil, and often occupying months in forming, because the injured tissues are deep-seated and fibrous. Blows or other outward forms of violence upon soft muscular structures, as the loin, quarters, or flank, may result in abscess in a few days, or at most weeks; while the galled withers of the riding-horse, or the shoulder of the harness animal, where the tissues are dense and tough, will be weeks and months, perhaps a whole year, in 'mattering' and coming to a point. The natural course is for the abscess to grow in volume, and the pressure of the contained pus to so press in the line of least resistance as to finally obtain exit through the skin, when it has caused absorption of the layers of which the latter is composed. As this period of disruption approaches, the abscess is said to 'point', and if left to Nature it finally breaks and discharges, this process being often facilitated by the animal's own movements, or contact with some solid object. When the contents have escaped, the process of repair (see art. Wounds) is usually rapid and uninterrupted, granulation taking place from the bottom of the cavity, and little or no blemish being finally left when cicatrization or scarring over has finished the work.



Microscopic Section of the Cuticle or Epidermis

A, Horny layer; B, C, D, E, intermediate young round cells becoming flattened as they approach the surface; F, derma or cutis vera.

Treatment. — The period during which an animal may suffer and be incapacitated from work, or from putting on flesh, can be curtailed by promoting the formation of pus, and shortening the time in which pointing will take place. Warm fomentations, poultices, stimulating liniments all help to bring this about, and some are applicable to animals under good control, and others to such as can only be handled with difficulty. The abscess of strangles may be poulticed; while the unbroken colt or beast at grass will derive some advantage from a single application of a mild vesicating agent, or strong liniment, needing but one application, yet helping to make the 'point' at which it is advisable to lance the swelling and evacuate the pus. When the finger indicates that the skin is thin, and that matter is fluctuating under its pressure, the abscess is ripe, and a single bold plunge of the instrument is the most merciful as well as effectual means of releasing the pent-up matter. Syringing out with a disinfectant also saves time by promoting the reparative process.

The majority of abscesses, as already hinted at, would ripen, discharge, and repair, without any interference, but would take longer, and in a few cases fail to break and discharge. As a result of such failure a caseous mass is formed, from which the more fluid portion is gradually absorbed, the remainder becoming more and more solid in course of time, and enveloped in a tough membrane.

Cold Abscess.—In some deep-seated and dense structures, as the shoulder joint, injuries are sometimes sustained which fall short of pustulation, but cause the parts to become hard and swollen and comparatively insensitive, yet irksome to the subject of them. This is especially the case with harness horses, which may be rendered unfit for labour by reason of the prominence and situation of the swelling. After many months, often far into a second year, these cold abscesses are still present, and the good surgeon will take measures to ripen them, even to the extent of injecting into their substance some irritant (as equal parts turpentine and tincture of iodine) which will provoke the formation of pus, and a regular abscess, such as we have described. Treatment on the lines already laid down will then be suitable.

Serous Abscess.—Another and more rapid kind of abscess, a day or two being sufficient for its formation. It does not contain thick matter like the phlegmonous or pus abscess already described, but a watery, straw-coloured or reddish fluid, the colour being determined by the amount of blood mixing with it as a result of the injury. To persons who have not seen the rapidity and extent of these swellings, much surprise will be felt, and incredulity as to the nature of them, if the short history is known to them; the lump will be expected to resolve itself as do many bruised conditions, and valuable time is in this way often lost. Such swellings do not, as a rule, show any disposition to 'point', but rather to consolidate by the thickening of the contained fluid, and the formation of a membranous covering. They are seldom so painful as pus abscesses, and do not require the same treatment; the essential thing being to lance them freely, and let out all the fluid before it undergoes the changes referred to above. A long incision is to be preferred, and a bold one; the operator avoiding any risk of injuring important structures by using his knife or lancet in an upward or outward direction. A gaping wound is left, and should be plugged with tow dipped in turpentine or other antiseptic dressing with known properties for promoting the healing process. Serous abscesses, if merely evacuated and left to themselves, have a remarkable disposition to reunion and refilling in a few hours; hence the importance of some means of keeping open until the true reparative process begins from the bottom of the cavity. Some will have formed a membrane which needs to be destroyed by such irritants as suggested for cold abscess, or by caustic solutions injected at frequent intervals. By such management serous abscesses seldom give any lasting trouble. Cattle are more prone to these than horses or other farm stock, and dogs are specially liable to serous abscess on the inner aspect of the external ear. For these animals it is most important that the lanced wound should not be allowed to reunite prematurely, or withering of the appendage is the result. This is even more the case with cats, whose value on the farm should entitle them to more consideration perhaps than is usual. [H. L.]

Absenteeism.—In agriculture this term is applied to the practice of landowners who generally or habitually reside away from their estates. Though it is in general an unfortunate practice, it is unavoidable in the case of landowners who are proprietors of estates situated in different parts of the country, or who, being engaged in the public service or in political life, find it imperative to reside where their duties call them. On some estates, as on those long held in the north of Ireland by London companies, the owners are of necessity always absentees. On others the absence may be due to the proprietor's distaste for a country life, his entire disregard of the duties that devolve on him in the influential position occupied by all landowners, or his desire to expend the income derived from the estate in travel, in town residences, and in some instances in horse-racing, gambling, and all manner of prodigality and dissipation.

The effects of such absenteeism are, as a rule, deleterious to the farmers on an estate, and they are invariably so in a high degree to the general community in which the estates are situated. The absence of the landowner implies the withdrawal from a district of the greater part of the income derived from his estates, and its expenditure in remote parts; and in Ireland in especial, where the country has been for centuries largely owned by non-resident English proprietors, it has been felt to be a bitter national grievance that the rents wrung by the peasantry from poor and unproductive soils should have been expended in London or on the Continent, and that the trade and business of the country from which they have been derived should have obtained so little direct advantage from them. The absence of a landlord from the estate which supplies him with his rents always involves the greater or less impoverishment of the district in which it is situated, while his residence on it has exactly the opposite effect. His retinue and attendants add substantially to a rural population, his benefactions assist the poor and the needy, his presence and his donations give important assistance to the causes of religion and philanthropy, and his influence on the public and the social life of a rural community, if exercised with wisdom and kindness, is great and beneficial. His expenditure on household necessaries for himself and his employees adds materially to the business and the incomes of the local shopkeepers, while the maintenance of his residence in good order, the culture of his gardens, the keeping of his parks and lawns, the additions and improvements to his mansion and its surroundings, which are invariably greater in the case of resident than of absentee proprietors, give employment to labour, increase the population, and produce a local prosperity, which imparts a feeling of contentment and gives a tone of comfort and happiness to the whole community. Whether the residence of the landowner is equally beneficial to the tenantry of the estate themselves is dependent on the local conditions and on the character of the proprietor himself. But if he be a just and fair-minded man, desirous of promoting the welfare of the people among whom he lives, his residence will usually lead to a more generous treatment of his tenantry and to a greater expenditure on the improvement of his property, with advantage alike to the estate, to the district in which it is situated, and to the general body of the people. [R. P. W.]

Absinthe, a name for wormwood, a plant of the genus Artemisia, family Compositæ, and for a liqueur flavoured with it. See ARTEMISIA.

Absorption of Salts by Soil. See MANURES, EFFECT OF, ON SOIL.

Acacia, a large genus of the sub-order Mimoseæ (nat. ord. Leguminosæ), indigenous throughout most tropical and sub-tropical regions. The leaves of many species exhibit sleep-movements analogous to those of the sensitiveness developed in the sensitive plant (*Mimosa sensitiva*) of Brazil. Among the Australian species the Wattle (*A. dealbata*) and many other trees yield valuable timber and tanning-bark. The largest Indian species, the Cutch tree (*A. Catechu*), furnishes excellent timber and also the valuable red-brown dye and astringent drug obtained by boiling chips of heart-wood and evaporating the water till a hard brittle mass can be formed in cooling. Gum-arabic is obtained from the *A. arabica* and other shrubs. In Britain, however, the tree usually called the Acacia is the Robinia, False Acacia, or Locust Tree (*Robinia Pseudacacia*), of Canada and the Northern United States, a genus of the Papilionaceæ (nat. ord. Leguminosæ) which was introduced here from Virginia by Robin in 1638. Botanically it is closely allied to the Laburnum, from which it differs not only by the colour of its white sweet-scented flowers (whitish-pink or pale-rose and scentless in *R. viscosa*, a smaller tree, and dark rose-coloured and scentless in *R. hispida*, a shrub, both indigenous to the south-western parts of the Alleghany Mountains), but also in having stipular prickles on its shoots and young branches. Known throughout North America as the Locust Tree, it occurs sporadically in small groups throughout the forests on patches of good, dry land. There its close-grained, finely-veined, yellowish timber (sp. gr. 0·87 green, 0·73 seasoned) is highly valued for its strength, hardness, toughness, and durability; while its rapid growth, its thorny spines, and its endurance of close clipping render its employment very suitable for hedges. In the warmer portions of Southern and Central Europe it is grown fairly extensively, and supplies very tough and durable fence-posts and rails, vine-stakes, ship's nails, &c. But in Britain this and the somewhat smaller *R. viscosa* are planted in gardens and avenues chiefly for the ornamental effect of their pendulous racemes of white, pinkish-white, or pale rose-coloured flowers, and their beautiful bright-green imparipinnate leaves, which flush late in the spring and are shed early in autumn. Although requiring shelter from heavy wind and liable to suffer from frost in the colder parts of Britain, its economic cultivation seems deserving of more attention than has hitherto been paid to it in the warmer portions of the United Kingdom. It freely produces good germinable seed, and can easily be raised and transplanted at two years old, when about $2\frac{1}{2}$ to 3 ft. high. But it can also easily be grown from cuttings or suckers. It stands transplanting better than most other trees, and easily establishes itself in its new position. It grows on any kind of land that is not wet or stiff, and deserves attention for the planting of poor, dry, and sandy soil, its growth being assisted by the formation and storing of nitrogenous and albuminoid substances in root-nodules through the symbiotic action of fungi. It needs a deep porous soil to develop its strong tap-root properly, and requires a large growing space to extend its light crown of foliage freely, for it is essentially a light-demanding tree, impatient of overhead or lateral shade. For this reason it is altogether unsuitable as underwood, although it coppices freely and well, throwing up both stool-shoots and root-suckers; but it is well adapted for interplanting as a standard over coppice. It should therefore not be planted closely, and may be freely thinned when the crowns of foliage begin to extend into each other. In Central Europe it has been grown to a height of 80 ft. and 8 ft. in girth, but these dimensions can hardly be expected in the cooler climate of Britain. Unfortunately, however, it is very liable to be gnawed by hares and rabbits. [J. N.]

Acacia or Locust Tree (*Robinia Pseudacacia*)

Acanthia columbaria (the Pigeon Bug).—This 'bug' is closely allied to the Bed Bug. Its food is the blood of pigeons and fowls. It is a large brownish bug about $\frac{1}{4}$ in. long, which attacks the birds chiefly at night, when it causes severe irritation and loss of blood. It is not common in Britain, but Railliet records it as so tormenting poultry on the Continent that sitting hens abandon their eggs. [F. V. T.]

Acariasis.—Diseases produced by Acari or Mites in man, stock, and birds. (See Mange, Sheep Scab, Scaly Leg.)

Acarina (Mites).—Jointed-limbed animals of the same group as spiders; many of them are parasitic on man and other mammals, birds, and plants. Many are very small, being no more than $\frac{1}{250}$ in. long. The group includes Mange Mites (Demodecidæ); Scab and Itch Mites (Sarcoptidæ); Plant or Red Spiders (Trombidiidæ), and Gall Mites (Eriophyidæ). They are oviparous, and the young greatly resemble the parents, but are six- not eight-legged. (See Sheep Scab, Mites, and Mange.) [F. V. T.]

Accession is a mode of acquiring property, or rather of enlarging an existing property, whereby the ownership of the principal thing draws after it that of its accessory. Thus the fruits of the ground, the young of animals, or buildings on the ground, though built with materials belonging to and at the charge of another, become the property of the owner of the principal. Exception, however, must be made of industrial fruits, which go with the property of the seed and labour. So, too, 'the insensible addition made to one's ground by retreat of the sea, the shifting of a river bed, or by what the water washes gradually from other ground', belongs to the property which receives the addition. If, on the other hand, ground is violently torn away from one property and deposited in a shape capable of identification along the bank of another man's land (Avulsion), the proprietor of the ground from which the land has been torn may vindicate his property. If an island be formed in a river, either by change in the bed, or the deposit of materials brought down by the stream and arrested in the channel, the general rule is that the island belongs to the owner of the bed of the river, that is, in the case of a navigable river, the Crown, and in the case of a private river, the proprietor of the ground through which it flows. If the river be a march between opposite proprietors, each having property in the bed to the middle of the stream, the ownership of the island will depend on its position relative to that line.

What has been said refers only to the changes which are the outcome of natural causes. If they are occasioned by the erection of an artificial structure, then if such structure has been erected on the lands of a third party or lawfully on the lands of the proprietor for the purpose of adding to his property, *e.g.* the erection of sea walls or embankments on navigable rivers, the property in the accession is governed by the same rules as if the accession has been natural. If, however, the erection is unlawful or beyond the landowner's rights, he will not be allowed to profit by his own wrongdoing. [D. B.]

Accident, Inevitable.—The legal term *damnum fatale* covers what is otherwise known as inevitable accident, *vis major*, or the Act of God, and has been defined as 'an event that no human foresight can provide against, and of which human prudence is not bound to recognize the possibility', or in the words of Lord James, 'an accident . . . due to natural causes, directly and exclusively, without human intervention, and that could not have been prevented by any amount of foresight, pains, and care reasonably to be expected'. Such an accident is a good answer to a claim for damages arising from alleged carelessness or neglect. For example, the tenant of a farm is bound to maintain the buildings, fences, &c., on the ground in good habitable repair, and so leave them at his removal, but this obligation is subject to the exception, *inter alia*, that the tenant is not responsible for damage due to causes beyond his control, such as an extraordinary hurricane or an accidental fire. [D. B.]

Acclimatization of Animals, the adaptation of animals, and of man himself, to a new climate. Its successful accomplishment is called *naturalization*. When representatives of a stock are transplanted or transported to a new country with different climatic conditions, they are often unable to adjust themselves to the change. They or their descendants die off, *e.g.* when reindeer are brought into temperate regions. On the other hand, they may be plastic enough to adjust themselves to the new conditions and survive. What happens in the course of acclimatization differs in different cases. (*a*) There may be individual adjustment of habits and ways of living, without any marked structural change, as in the case of the European sparrows taken to North America, or the rabbits taken to Australia and New Zealand. (*b*) There may be individual acquisition of definite structural peculiarities, directly due to the changed conditions, and reimpressed on each successive generation, without ever becoming in the strict sense hereditary, as when animals acquire longer and thicker hair after transportation to a colder climate, or when Alpine plants are removed to a southern garden. (*c*) There may be a slow racial change, due to germinal variations, and to the survival of those which are relatively fittest to the new conditions. These germinal variations may be indirectly prompted by the stimulus of the novel climate, but we do not really know the nature of their origin. What we know is, that they are inborn, not acquired, that they are continually cropping up in various degrees and in many forms, that they are transmissible though not always transmitted, and that they may in the course of selection become constant characters of a race suited to the new climate, and 'naturalized' there. It need hardly be pointed out that these three kinds of change (*a*, *b*, *c*) may be all occurring at the same time in the same organism. When races spread into new territory with similar climate, we have to do simply with dispersal, not with acclimatization. When man takes charge of the migrants into a new country, *e.g.* brings silkworms from China to Europe, or takes his stock of sheep, cattle, and the like to the Colonies, the process of acclimatization merges in that of sustained domestication. It is well known that while some animals and plants are acclimatized very readily—often too readily, as the sparrows and weeds in North America remind us—other creatures are extremely sensitive to change, even when it seems to us a slight one, and persistently die out in their new home. Experience shows that gradual acclimatization is often possible though a sudden change is fatal. A few illustrations:—Such animals as sheep, (especially Merinos), cattle, deer, dogs, cats, and poultry have been successfully acclimatized in areas very different from those from which they were taken. Silkworms, also, have been successfully acclimatized in Europe, camels in Australia, reindeer in Alaska, trout in Australia, &c. Among plants, the coffee plant has been introduced successfully into the West Indies, the cinchona into India, the eucalyptus or gum-tree into California and (along with some other Australian plants) into the island of Arran, the tea plant into some parts of the United States, and the tobacco plant into Ireland; while different varieties of wheat, maize, potato, orange, vines, and many other useful plants have been acclimatized in new countries with complete success. On the other hand, attempts to acclimatize the camel in Arizona, the alpaca in the same territory, the ostrich in California, and European dogs in India have proved unsuccessful. The acclimatization of the house sparrow and various weeds in North America, of rats and mice almost everywhere, of rabbits in Australia and in New Zealand, and of the Canadian Pondweed (*Anacharis canadensis*) in British canals and rivers has proved extremely detrimental, and such cases remind us that acclimatization should not be attempted without due consideration and careful advice from experts. [J. A. T.]

Acclimatization of Plants.—*Acclimatization* may be defined as the gradual adaptation of a plant (or animal) to a climate other than that of its natural home. There can be no doubt that the process of acclimatization is continually going on in nature, although so imperceptibly as to be almost unrecognizable. Many plants are continually extending the limits of their zone of distribution, and are bound sooner or later to encounter climatic changes; in many regions of the world, moreover, the climate has undergone modification within human knowledge. In both cases if the change be a gradual one a considerable number of plants will probably become acclimatized to the new conditions, while a sudden change of climate is certainly fatal in the large majority of cases. Good examples of failure of plants to adapt themselves to a climatic change are given by Martins (Mémoires de l'Académie des sciences et lettres de Montpelier, section des sciences ix, 1877-8 (1879), p. 187 and foll.). According to him, certain plants growing in the neighbourhood of Montpellier (e.g. *Euphorbia dendroides*, *Anagyris fœtida*, *Myrtus communis*—the common myrtle) are much injured by occasional frosts, which may even in some cases lead to the death of the individual. (The myrtle only persists at one point and shows a gradual decrease in number of individuals.) *Chamærops humilis*—the common fan-palm, which occurs in abundance in the south-western part of the Mediterranean region, is now only found in one locality (near Nice) on the Riviera, and is even there gradually dying out. The history of our own flora shows a gradual change of climate, and the fossil records testify to the complete change of vegetation which has been brought about thereby.

In nature acclimatization is probably always a very gradual process, but up to the present scarcely any attempt has been made to imitate this in practice. Acclimatization, as effected by man, has consisted in the cultivation, with more or less success, of exotic plants in new climates, differing more or less widely from that of the natural home of the plant. As examples we may mention the successful cultivation of Cinchona in India and the Sunda Islands, while the attempt to introduce tea into France was a complete failure. In the former case the difference of climate was not very great, in the latter too great to admit of acclimatization. The term acclimatization has moreover very often been loosely applied, and very few cases of so-called acclimatization have been accurately investigated. A plant can often be cultivated in a country far removed from its native home, because the climatic conditions are practically identical; in such a case we cannot speak of acclimatization, and the term *naturalization* has been applied to these phenomena, examples of which are afforded by the successful growth of many Eastern American trees in Central Europe, and of the American Opuntia in Southern Europe. To establish a case of true acclimatization it is essential that a difference in climate should be involved; and there are very few cases of this kind that we can regard as fully authenticated. Cereals perhaps furnish the best examples, for although many are cultivated over the greater part of the earth, they are really indigenous only in a few countries. With the introduction of more rational methods we may hope to effect acclimatization of many plants which have as yet afforded negative results. Many so-called failures in experimental acclimatization are probably due also to negligence as regards the soil-conditions (see below). We must of course always be prepared to find that, even if a plant can be made to grow in a new climate, the latter may call forth or suppress some particular property, as a result of which the acclimatization of the plant becomes valueless from the economic stand-point. Examples are afforded by the loss of the power of flowering and fruiting in many of our fruit-trees when grown in the Tropics.

In nearly all the published literature on acclimatization, change of temperature is practically the only factor dealt with (see, however, Naudin in Annales des sciences naturelles, Botany, sér. 6, t. v. 1878), although a scientific study of the subject is obviously impossible without a consideration of all the meteorological conditions involved. The most important factors liable to differ in two climates are temperature, rainfall, light-conditions, and wind; of these the first two are by far the most essential. The existence of every plant is possible only between certain limits of temperature (the minimum and maximum), and if the temperature fall or rise beyond these limits, the death of the plant ensues sooner or later. These limiting temperatures, which are called the 'cardinal points', are almost constant for individuals of one and the same species, although they vary very considerably for different types of plants. The most important distinction that can be drawn in this respect is between plants which withstand frost (so-called frost-hardy plants) and those which are fatally injured if the temperature fall below freezing-point (for the influence of frosts on various exotic plants, see Naudin, as above, p. 337). Many tropical plants cannot stand prolonged exposure even to temperatures below 5° C. (41° F.), whilst on the other hand many Arctic and Alpine plants resist temperatures which are far below the freezing-point, and between these two extremes there are innumerable transitions. There is nothing in the external appearance of the plant to indicate the temperature limits to which it is adapted; they reside wholly in the protoplasm and are an inherent property of the latter. Every one of the numerous functions of the plant likewise requires a temperature above a certain minimum and not exceeding a certain maximum, although these cardinal points, like those requisite for the plant's existence, are no doubt subject to some slight alteration according to the nature of the remaining conditions (moisture and light) to which the plant is exposed (for a description and criticism of phenological methods, see F. Darwin, in South-Eastern Naturalist, 1906). The cardinal points for the different functions of a plant do not coincide with the cardinal points for its existence as a whole; thus the limits within which vegetative growth is possible are generally wider than those for the formation of reproductive organs. When subjected to new climatic conditions the different cardinal points can no doubt in many plants readjust themselves to some extent, or in other words acclimatization to change of temperature can take place. 'The possibility of acclimatization always varies with the species; in some it appears to be unlimited under natural conditions, while in others it takes place only within very narrow limits. Complete acclimatization is therefore only possible when all the cardinal points change in harmony with the new temperatures. If this is not the case, or not sufficiently so for certain functions, acclimatization is confined to definite processes and the plant either is not capable of existing or does not develop completely' (Schimper, Plant-geography, Eng. trans., Oxford, 1905, p. 49). Good examples of such partial acclimatization are found in the non-formation of flowers or fruits in many of our fruit-trees when planted in the Tropics (see below), and in many plants of warmer climates when transferred to temperate regions.

Next to temperature the most important factor to be considered in relation to acclimatization is a change in the amount of rainfall. This may either affect the plant directly or indirectly. Thus if the change is in the direction of increase, it may cause rotting of the leaves or roots, but in the vast majority of cases the effect on the plant will be indirect, involving a change in the water-content of the soil to which the dependent physiological processes of the plant are unable to respond. Assuming that the soil in the new habitat is identical with that in which the plant normally grows, a higher or lower rainfall, as the case may be, may render acclimatization impossible, even though the temperature conditions be suitable. There is, however, a good deal of evidence to show that acclimatization to changed conditions of rainfall is more readily effected than acclimatization to temperature (see also article on ADAPTATION, POWER OF, IN PLANTS), although the subject is rather a complicated one, being intimately bound up with the physical nature of the soil. The cultivation of an introduced plant may prove to be unsuccessful in one locality, although attended with success in a neighbouring area, and that, although the temperature and amount of rainfall are identical in the two cases. Under such circumstances the nature of the soil will probably furnish an explanation for the apparent anomaly; if, for instance, it be sandy in the one locality and clayey in the other, the soil of the former will be much drier than that of the latter, and consequently if the rainfall be greater than in the normal habitat (which we will assume to have a clayey soil) of the plant, the latter may on the sandy soil find suitable moisture conditions, while the clayey soil will probably be too wet. The quantity of moisture retained in the soil is also markedly dependent on its humus-content. These few remarks will suffice to show that an accurate study of acclimatization is impossible without drawing rainfall and soil-conditions into our considerations.

There are very few data as to the possible influence of light in acclimatization, but it is probably in no way as great as that of temperature and moisture. The intensity of the light, of course, varies very considerably in the different climatic zones, while the gradual increase in the duration of the summer day as one advances from the Equator towards the poles is another important factor. Certain intensities of light and their realization at the right time exert as important an influence as temperature on certain functions of the plant, but the variations of light-intensity in nature do not as a rule pass outside the limits required by the plant. In the case of *Mimulus Tilingii* it has been shown that flowers are not formed if the light is below a certain degree of intensity, and similarly the low light-intensity may be the cause why so many plants of warmer climates rarely or never flower in our hothouses (see below), where a suitable temperature is provided for them. This is possibly due to the fact that the low light-intensity decreases the assimilatory activity of the plant. As an example we may mention the case of *Clusia flava*; according to Solms-Laubach all attempts to produce flowers in this plant were unsuccessful both at Göttingen and at Strassburg, while in Italy it flowers abundantly in the open air. In experimental acclimatization it is also obviously necessary to know whether the plant in its normal habitat is exposed to shade or to the full light.

The influence of wind, like that of moisture, may be direct or indirect. If the plant has not been exposed to much wind in its own home, it may be incapable of withstanding the mechanical strain in a windy region. More commonly, however, the effect of a windy habitat is indirect; transpiration goes on more rapidly and the moisture-demands of the plant increase. In a windy region, moreover, the influence of low temperatures is much more pronounced, so that the relative exposure of plants is a consideration of some importance, acclimatization in some districts being possible only in sheltered situations.

As an outcome of the considerations in the preceding paragraphs it will be evident that acclimatization depends on a variety of conditions, many of them mutually interdependent and bound up with one another in such a way that their proper elucidation is attended with great difficulties. It is therefore not surprising that opinions differ very widely as to the power of acclimatization possessed by plants. In many cases it is quite impossible in the present state of our knowledge to say whether we are dealing with true acclimatization, and practically none of the examples mentioned below have been subjected to a detailed investigation.

We may first consider the influence of a change of climate on trees. The possibility of acclimatizing exotic forest trees has been discussed at great length by Heinrich Mayr (see Die Waldungen von Nord Amerika, Munich, 1890; and more especially Fremdländische Wald- und Parkbäume für Europa, Berlin, 1906, p. 197 and foll.); his observations lead him to the conclusion that no true case of acclimatization of a forest tree has been established. According to Mayr, many so-called cases of acclimatization (*e.g.* the successful growth of many East American trees in Central Europe) are due to the new climate differing in no essential respect from the old one. Mayr states that it is generally impossible to accustom a tree, which never encounters frosts in its own home, to frosts occurring during the active period in the annual cycle of the plant. Certain exotics may withstand frosts, if they set in during the resting period, but early (autumn) or late (spring) frosts are always fatal to plants unaccustomed to them. In support of this statement Mayr refers to the effect of such frosts on Gleditschia and *Robinia Pseudacacia*, both of which were introduced into Europe several centuries ago; early or late frosts invariably kill the apices of many of the shoots, and in very severe winters (*e.g.* that of 1879-80) numerous individuals are killed outright. Although they have been exposed to these conditions for centuries these plants have been unable to evolve a race with a shortened active period, so as to meet the untimely frosts in the resting condition; and this in spite of the fact that European specimens are always grown from seed derived from trees cultivated in Europe. Similarly in the Mulberry the leaves often remain on the tree till December, which in severe winters must be disastrous to the plant (for the effect of unusual frosts on tropical forests, see a series of articles in the Indian Forester for 1906 and 1907). The transference of a tree from a cold (temperate) climate to a warm (tropical) climate is almost as difficult as the reverse process; the effect of the high temperature all the year round is to disturb the regular periodicity of the tree and often also to modify its mode of growth, so that, even if the change of climate is not fatal (as is frequently the case), the general character of the tree may be materially changed. Periodicity is an inherent property of a tree and does not depend directly on external conditions, although in most cases it has become adapted so as to coincide with the alternation of seasons. Thus in temperate climates the periodicity of a tree is related to the alternation of summer and winter, and in some tropical climates to the alternation of a sharply defined wet and dry period; but in many parts of the Tropics in which the climate is more uniform the trees show quite an irregular periodicity, one branch dropping its leaves while another is just unfolding them, and so on. The effect of a climate like that last mentioned on trees indigenous in temperate regions is shown by the behaviour of the Oak, Apple, Pear, Tulip Tree, &c. (all of them deciduous) on the slopes of the volcano of Gedeh at Tjibodas in Java. 'The buds expand not simultaneously but successively, so that an individual plant bears at the same time spring, summer, autumn, and winter shoots. Each bud shows the usual periodicity, but that of the plant as a whole has gone, and it disappears at Tjibodas in the course of a few years.' (Pfeffer and Ewart, Physiology of Plants, Oxford, 1903, vol. ii, pp. 212, 213.) Similarly the Cherry and Peach become evergreen in Ceylon, while leaves, flowers, and fruits are to be found all the year round on peaches (and strawberries) in Java, and on the European vine at Cumanà in Venezuela, and at Khartoum in Central Africa. On the other hand, a slight seasonal change in the annual temperature (possibly also in illumination) is sufficient in many cases to preserve the periodicity of the tree; thus, many of our common foliage trees have been planted in Madeira, where in spite of the uniform character of the climate they still show a winter period of rest, although the lowest average monthly temperature at the time is 15·4° C. (60° F.). The resting period is, however, often much abbreviated; thus, the leafless period is 149 days in the Beech, 110 days (*i.e.* 45 days less than in Switzerland) in the Oak, and 87 days in the Tulip Tree, while the Peach is practically evergreen, some trees flowering already in the autumn, and others at diverse times in the course of the winter. Many indigenous plants (and tropical exotics) are active throughout the mild winter of Madeira, so that the climate obviously does not necessitate the period of rest exhibited by Beech, Oak, &c. A similar relation obtains at Nice, where owing to the mild winter many indigenous plants begin to sprout in January, while Oak, Beech, Elm, &c., delay foliation to April. In many cases the transference of a temperate tree to the Tropics, while not resulting in the death of the plant, leads to the cessation of certain functions, especially formation of flowers and fruits; thus on the heights of Nuwara Eliya in Ceylon the Cherry flowers but forms no fruits, while the fruits of the Peach are very poor in quality; the same result has been obtained in cultivating many of our common fruit-trees in British Guiana. It is generally assumed that this is due to the minimum temperature not being low enough for the initiation of the necessary conditions for flower- or fruit-formation. Phenomena analogous to those just discussed are observed in exotic plants cultivated in Europe. Many plants from the Southern Hemisphere retain their wonted periodicity for some time in our climate before accommodating themselves to the altered seasons, while plants from warmer climates fail to flower or to form fruit. The vine rarely matures its fruits in the open air in England, although otherwise successful; the summer temperature is lower than in the vine-growing areas of the Continent, and does not attain the necessary minimum for fruit-formation. Similarly at the North Cape the Birch grows as a low bush, but never forms any fruits.

A slight increase of temperature is often favourable to the growth of the plant. Thus the Oak in sub-tropical regions like California or parts of Australia attains a height of over 22 ft. in about nine years, while certain Japanese Oaks (*Quercus glandulifera* and *Q. serrata*) attain the same dimensions in eight years in sub-tropical zones as in fifteen years in the temperate climate in which they are indigenous. As a rule, a slightly increased temperature is far more harmful to Conifers than to ordinary foliage trees; acclimatization of the former to such conditions is either quite impossible, or the growth of the plant is so enfeebled as to make it of no practical value. The Spruce Fir, for instance, when transplanted from its normal habitat into the warmer zones frequented by Beech and Oak, at first grows very rapidly in height, but the power of growth soon ceases and the tree never attains a sufficient development to render it of any economic value. In many cases, moreover, transference of a plant to a slightly different climate, although otherwise successful, becomes impossible owing to an increased liability to disease--often to some new form of disease unknown in the natural home of the plant.

There are not many data to show the influence of conditions other than temperature-change on the acclimatization of trees. A greater amount of moisture in the air favours the rate of growth, as is well illustrated by the rapid-growing tall trees found in the forests on the coasts of the Pacific. If a plant is brought into a drier climate it appears that in some cases a greater degree of moisture in the soil may compensate for its absence in the air. According to Mayr, a tree growing near its upper temperature limit requires a relatively moist soil, and near its lower temperature limit a relatively dry soil. In its climatic optimum the swamp cypress (*Taxodium distichum*) of America occupies a marshy habitat; at its Southern limit the base of the plant stands in the water for the greater part of the year, while in its coolest zone of distribution it grows in a moist soil. If cultivated in a still cooler climate (*e.g.* in the beech zone) it is killed by frost in a few years' time if placed in marshy ground, while it persists on ordinary soil, although never becoming well developed.

Not much exact information as to the acclimatization of plants other than trees (shrubs and herbs) is forthcoming. It would appear as though in some of these cases there is a very considerable power of acclimatization (greater than in trees), which is perhaps most pronounced in cereals and other common food-plants. The course of the life-history here from germination to maturation of the fruit is capable of considerable modification to suit external conditions, numerous examples of which are given by Hermann Hoffmann (Witterung und Wachstum, Giessen, 1857, p. 530 and foll.). The following data, dealing chiefly with barley, may be mentioned. In England a special rapid-ripening kind of barley has been harvested within two months of sowing. In Russia, where the summers are shorter but warmer than in France, barley ripens in less than two months, while in France it rarely takes less than six to seven months. In the warmer climate of Spain two harvests are possible, one in the spring from seed sown in winter, the other in the autumn from seed sown in summer. In the valley of the Nile in Egypt barley is sown in October and November, grows during the cool period of the year, and is harvested in February. At Nertschinsk in Siberia, where the average yearly temperature is $-3{\cdot}2°$ C. (26° F.), certain kinds of corn and barley are harvested within three months of sowing, although the soil at a depth of 7 ft. remains frozen throughout the year. In Lapland barley gives a good harvest in all parts, where the temperature in the summer months attains 8° or 9° C.(48° F.). In the Swiss Alps, cultivation of barley is only possible up to a certain height, which lies below the uppermost limit for the growth of trees, whilst in the Cordilleras it is cultivated far beyond the tree limit. In the latter case the average temperature is only 5·6–6·8° R. (44·5–47° F.), but the temperature is much more constant than in the Swiss Alps, where the higher summer temperature is not sufficient to compensate for the shortness of the summer. In the north of Norway barley is cultivated up to 60–61° N. lat. and up to a height of 200 ft.; in Lapland it is grown up to 800 ft., while in the Tropics (Peru, for instance) barley is found up to a height of 13,050 ft., although it no longer ripens at these altitudes. The varied times of ripening of barley and potato are also illustrated by the following table:—

BARLEY

Copenhagen	113 days
Wernigerode (Harz)	106 ,,
Alsace	92 ,,
Cumbal (Andes)	168 ,,

POTATO

Copenhagen	124 days
Wernigerode	168 ,,
Bogotà (S. America)	200 ,,
Mt. Antisana (Ecuador) ...	276 ,,

A good example of the gradual adaptation of cereals to altered conditions is given by Schübeler. In the year 1852 a certain kind of maize grown in the neighbourhood of Stuttgart was planted in Norway, the period between sowing and harvesting being 120 days. In the course of the next years this maize matured at a progressively earlier date, so that in 1857 it was harvested 90 days after sowing. Similarly the hastened life-cycle of cereals grown in northern climates becomes gradually lengthened (generally in from two to four years) in warmer climates as the plant adapts itself to the new conditions; and in the same way many Alpine plants, when cultivated in the plains, lengthen their active period, and vice versa.

There is one aspect of experimental acclimatization that has not yet been touched on. The seeds of any given species of plant do not all commence germination at the same time, nor do we find that all the individuals of one kind of tree or bush come into leaf simultaneously. The interval between the earliest and latest individuals to awaken to vegetative activity is often as much as six weeks. The early individuals are liable to be exposed to late frosts and in many cases are killed in large numbers, although many herbs withstand frosts quite well, even if they occur during the active period; those, however, which prolong their resting period till late on in the spring, escape these frosts. By a process of selection it should thus be possible to breed a race of late individuals adapted to live in localities in which late frosts frequently occur. In the same way we find a considerable range in the date at which different individuals of the same species bring their vegetative activity to a close in the autumn; in this case, those which enter on the winter period of rest soonest, are immune against possible early (autumn) frosts. It would seem that Burbank (see Harwood, New Creations in Plant Life, New York, 1906, p. 194 and foll.) has been to some extent successful along these lines in breeding races of fruit-trees capable of withstanding late frosts. In the case of cereals and other food-plants, Nilsson's work carried on at the Swedish Agricultural Experiment Station at Svalöf has demonstrated the fact that the so-called varieties include a large number of practically constant types, which show a great range of adaptation to external climatic conditions (see De Vries, Plant Breeding, London, 1907, p. 77). Finally, as the scientific study of grafting and hybridization progresses, these methods will no doubt prove of paramount value in breeding new races, capable of acclimatization to varying combinations of climatic factors.

[F. E. F.]

Acclimatization Value.—Domestic animals bred and reared on farms have their conformation and physique determined by two factors — the conditions of their environment and the selective control of breeders. Human selection working in reasonable harmony with the forces of nature brings about the evolution and fixing of breed and species characteristics much more quickly than the slow elimination of the unfit by death would allow. On lowland farms where cultivation, fencing, feeding, housing, and other artificial adjuncts are brought into play, human control is the stronger and more determinative of the two forces, though its scope is not unlimited by elements outwith man's power to regulate. The market reputations, which particular lowland stocks of farm animals have acquired, arise almost wholly from the well-directed use of the owners' superior skill and intelligence on the problems of breeding, rearing, and feeding. But even with lowland stock successful dealers and purchasers must acquire by experience, or from tradition, the range of underlying inherent qualities of the animals in the various districts from which they derive their supplies.

Above the line of cultivation the selective efforts of breeders have to contend with a stronger tendency of the natural conditions to be reflected in some features and characteristics of the stock carried. The quantity and nature of the plants which supply the pasture are determined by the composition and depth of the soil; by altitude, exposure, rainfall, and other climatic agents. Size, weight of bone, kind of hair or wool, shape of front, and to a less extent colour of animals, are all subject to modification by environment where the native plants are the main or sole source of food to the stock, and where the extent and slope of the areas grazed come into the reckoning. Animals, especially sheep from high-lying districts, have their market values determined by character for doing or not doing well as much as by visible qualities. In this case purchasers pay conscious tribute to the strong silent moulding forces of soil, climate, and other geographical factors that co-operate to produce a consistent response in the transported stock to the stimulus of a fresh and better habitat.

While there are more or less modification by and adaptation to environment on all farms, it is only in the case of the sheep breeds which occupy the higher grazing areas that this acclimatization has a definitely recognized commercial value. The custom of binding stock to the ground to be purchased at a change of tenancy, either by the landlord or by the incoming tenant, had its origin in a reasonable basis. Sheep on extensive grazings retain some traces of habits that have persisted from their wild days, and stock bred on particular holdings is better adapted to these, and worth more to the tenant than any other animals of the same breed would be. This additional worth may be regarded as arising from three groups of causes—adaptation and acclimatization proper, 'salting' or acquired comparative immunity from some diseases prevalent locally, and convenience. On all pastoral holdings one or two or all of these three require consideration. The physical configuration, the food supply, and the climatic variations tend to stamp themselves on the type, size, and form of the animal, and the resultant is a compromise between these and the ideal aimed at by the breeder in his selections. A new owner who may wish to modify his predecessor's model is better to begin on the foundation of a domiciled stock, unless, of course, he desires to change the breed or system of working.

The question of acquired immunity to some diseases does not fortunately arise everywhere, but where it requires to be considered it is the most serious factor in increasing the value of a stock bred and reared on land known to be deadly. The braxy group of diseases, louping-ill or trembling, and some others, take their heaviest toll in the first year of the sheep's lives, and the survivors are less liable to succumb to these particular disorders in succeeding years. This protective 'salting' is possible of acquisition, because many sheep ailments, including those named, are remarkable on account of their seasonal virulence. Within narrow limits of time the victims may be numerous, while through the remaining months few deaths are so caused. Those that escape during the deadly seasons are supposed to have been infected and affected at a time of the year when their systems could successfully resist the disease germs, and have thereby been rendered proof against later attacks. Recent researches have raised hopes that by preventive drenching of young sheep the losses will be reduced. At present, on land where these diseases are endemic, acclimatized animals above one year have an increased value as stock, being likely to live, while importations would be liable to double or treble decimation. And it is not by any means the least choice specimens which die off, so that the attempt to put on a fresh stock on tainted land is at once a costly and a heart-breaking undertaking.

Away from the unhealthy districts, and on walks where the death-rate is never alarming from endemic causes, the advantages of a 'hefted' stock may be best described under the term, convenience. Whenever animals—sheep more than cattle—have sufficient freedom and scope, they retain or readily revert to habits and times of feeding and resting similar to what may be found in allied undomesticated species. According to the extent of ground and the nature of its surface, there will be proportionately less loss by straying, by drowning, or by other accidents when the incoming owner takes over the possession of beasts that have a strong homing instinct and a life-saving knowledge of the rocky or wet dangers—instinct and knowledge that have been intensified in each successive generation. Where the bounds are wide, bought-on stock requires more close, and therefore more costly, shepherding, which is relatively ineffective as compared with inherited instinct in preventing losses. Strange to their surroundings, the newcomers require to be parcelled out in groups, to which are allotted definite areas over which to travel and from which to gather the year's sustenance. A breeding flock contains always regular numbers of different ages up to the limits at which drafts are sent out for sale. Though it can scarcely be strictly described as an element of acclimatization value proper, yet this distribution of ages and maturity is so convenient that it is worth paying for at the beginning of a tenancy or ownership.

The appraising of the money value of acclimatization and convenience in all the circumstances of a holding and its flock may, and often does, lead to acrid discussion and violent differences of opinion before all details are adjusted. Notwithstanding these practical difficulties, the custom has a sound scientific basis to justify it, and throughout the 19th century there was a growing tendency on the part of valuators to assign a higher value to the advantages resulting from acclimatization and convenience in fixing prices at which stocks should be taken over by new tenants. In the beginning of the century, from 2*s.* to 3*s.* per ewe was regarded as ample 'loading' in respect of acclimatization. At the present time the additions made to market rates on account of sheep stock being acclimatized vary more widely according to the extent to which the factors above enumerated prevail. For example, in Argyllshire, Dumbartonshire, and the western portion of Perthshire the rates are high, as the land in these counties is difficult to restock on account of a more or less natural unhealthiness, and from the fact that the land is frequently unfenced. The following may be taken as average rates in those districts:—

Ewes and lambs ...	17*s.* to 21*s.* per ewe and lamb.
Eild ewes and ewe hoggs	10*s.* to 12*s.* each.
Wedders	4*s.* to 5*s.* ,,
Tups	£2 to £3 ,,

In Perthshire and the hilly part of Forfarshire, where the land is naturally healthier and fencing more plentiful, the rates may run as follows:—

Ewes and lambs ...	10*s.* to 15*s.* per ewe and lamb.
Eild ewes and ewe hoggs	5*s.* to 9*s.* each.
Wedders	2*s.* to 3*s.* 6*d.* each.
Tups	£1 to £2 each.

The higher rates apply to West Perthshire and the lower to East Perthshire and Forfarshire. In the south of Scotland and north of England, where the tenant has a right to an acclimatized valuation, the rates are of course much lower. £5 to £6 per score in the case of ewes may be taken as the maximum 'loading' in those districts, unless in exceptional cases. [J. ST.]

Accounts, Farm.—"Bookkeeping" is the art of recording the transactions of a "concern", so that it may be ascertained at a glance whether and in what degree its affairs are prosperous or otherwise. No merchant ever dreams of carrying on his business without his "books"; but among farmers, the practice of keeping accounts, though now more general than was formerly the case, is yet sadly neglected. Yet if the subject be studied, no argument will be found in favour of this practice by the one class which is not equally binding on the other. It is true that the exact value of the assets cannot be so readily found in the case of a farm as they can in businesses of a purely trading or manufacturing character, but an estimation sufficiently close for all practical purposes can easily be obtained. The evils which the neglect of bookkeeping has entailed upon agriculture are not confined to mere pecuniary losses suffered by individuals; they are to be seen in the extremely unsettled state of almost every important point of farm practice. With the development of the spirit of observation, and the habit of recording observations, which are apparently being acquired by the rising generation of farmers as a result of the attention which has been directed to agricultural education in recent years, farm accounts will no doubt receive a greater share of the attention which they deserve as aids to successful practice.

A chief obstacle to bookkeeping by farmers has arisen from the want of sufficiently simple methods; the systems which have been published require either more time than the farmer can spare, or greater skill than he can command. And as the works in question have generally been the production of persons employed in mercantile pursuits, who, quite alive to the necessity of the Balance Sheet, are yet ignorant, not only of the difficulties of introducing a novelty in agriculture, but also of the peculiar nature of the transactions to be recorded by the farmer, this is what might have been expected. A method of agricultural bookkeeping must be marked by the utmost simplicity and facility, consistent with efficiency, in order to its general adoption. While so full in its details as able to present at any time a perfect view of the farmer's financial position, it should be so simple as that, in his absence, the necessary entries may, without risk, be entrusted to the foreman. Several satisfactory systems of farm accounts meeting these requirements, and each possessing some particular advantage, might be described, but we have elected to deal somewhat fully with one which we think is suited to a large body of farmers,—those farming medium-sized farms on which no retail trade, such as in a milk or poultry business, is carried on, and on which the credit transactions are, in consequence, not numerous.

The first book required is the *Memorandum Book.* The memorandum or pocket book should, as its name implies, be the farmer's constant companion. It should be of a convenient pocket size, and made of good, stout paper, in order that the memoranda in it may be permanent; for, being the basis of all the others, it will prove a most important book for reference. Every transaction of any interest connected with the farm, with the date of each, should be entered in it. All moneys received and paid must be entered at the time of the transaction, and the nature of the proceeding should be clearly stated; nothing must be trusted to the memory. The entries, however, should not be confined to this class merely, but the time when the several crops are sown, reaped, or stacked—any ascertained weights of produce—remarkable variations in the weather, &c.—indeed everything of general interest to the farmer should be noted down at the time when it occurs. If thus carefully kept, this book becomes one of great usefulness; the farmer will be able, by means of it, to compare his present with his past experience, on any point of farm practice. If a little care be taken at first in making all these entries, it will be found to save much time afterwards, and it will beget a habit of neatness which is of essential service. The necessity for accuracy is plain, for this is the book from which we must gather all the information for the general accounts.

The extracts on the next page, from the memorandum book of one who has just entered his farm, will explain the mode in which it should be kept. The farmer in this instance is supposed to have entered on a farm where his predecessor, giving up farming altogether, disposes of the whole of his stock, horses, implements, cultivation, &c., to his successor. The first entries are to the effect that on the day he took possession he opened a banking account and paid the outgoing farmer for the whole, as specified in the *award*; its value being arrived at by arbitrators appointed, one by each party.

These extracts will suffice to illustrate the way in which the Memorandum Book should be kept; but it may be made much fuller of general information, and this would be of great service to the farmer hereafter. The most useful of all lessons in agriculture are to be learned by attention to the ordinary operations of cultivation. By keeping a journal of them all as they succeed one another, and by recording his estimate of the effects of each upon the subsequent crops, the farmer will far more rapidly mature in agricultural experience, and acquire with greater certainty what degree of foresight is attainable in the practice of farming, than if he should trust his unassisted memory. The habit of closely comparing recorded estimates with ascertained results in the field will soon confer this experience, which in the more common custom of negligent routine is only gained in the course of many years, and then only by the more intelligent of those who adopt it.

The Labour Book.—It is on the form and arrangement of this book that much of the conciseness and simplicity of any system of farm accounts will depend. Payments for labour being the principal items in the farmer's expenditure, and being so varied both in amount and in the object for which they are incurred, it would be endless work to pursue the same course with them as with other expenses which are of larger amount or on fewer accounts. One man during the course of a single week may be employed at a great variety of work: in hoeing wheat, turning manure for the turnip crop, and in planting mangels, for instance. The occupations on the farm being so dependent on the weather and other influences, these will necessarily guide the disposition of the labour upon it; and the difficulty of keeping an accurate account of this class of expenses is very considerable. In fact, many farmers, rather than be at the trouble of noting these ever-varying occupations, neglect the subject altogether. In the case above referred to, the wheat, the turnip, and the mangel crops have been benefited by the man's labour; and others have been employed in the same way, and probably among other crops as well; so that during this week all the crops cultivated on the farm may have been indebted to different people for an amount of work for which so much money has been paid. Now to charge each of these crops with the actual amount incurred by each of the labourers would, in the usual way of ledgerizing each separate payment, occupy the whole of the farmer's time. Many hundred entries would have to be made in the month on account of labour alone. With a systematic arrangement, however, such as we shall now describe, comparatively few suffice, *i.e.* supposing the farmer to pay his men once a fortnight, each crop having been benefited during that time.

The leaf from the labour book on pp. 21 and 22 show better than a written description the form we recommend. It supposes the farmer to pay his men once a fortnight, a time that certainly should not be exceeded. We would here recommend that wages should be paid on any night rather than the Saturday. Thursday or Friday night is quite as convenient for the employer, and is much preferred by the labourers, who are thus enabled to choose their market, as before the end of the week they have ample time and opportunity to make all necessary purchases where they please; they are no longer forced by circumstances to attend the village shop, and suffer from the monopoly established

EXTRACTS FROM MEMORANDUM BOOK

1907.			£	s.	d.
April	1	Took possession of Mount Farm, 270 acres arable land, having taken it on a lease for 15 years, at the annual rent of £405, payable half-yearly on Oct. 1 and April 1.			
		Opened an account at ——— bank: paid in £2800; cash in hand £10.			
		Paid for value of stock and cultivation on the farm, as per award (cheque)	1718	16	4
〃	3	Paid expenses to ——— market	0	2	6
〃	3	Purchased 4 tons steamed bone meal from J. Morris & Co. at 75*s.*	15	0	0
〃	3	〃 20 cwt. seed potatoes from J. Cullimore at 4*s.* 9*d.*	4	15	0
〃	11	Paid J. Cullimore for potatoes	4	15	0
〃	17	Bought from L. Strange feed-measures for stable, and paid	0	5	0
〃	18	Drew from bank	30	0	0
〃	18	Paid wages two weeks ending this date (see Labour Book)	18	0	0
		Commenced planting mangels this week.			
〃	20	Paid M. Parry for 7 bullocks purchased this day at Stow Fair (cheque)	74	7	6
〃	20	〃 S. Charles for 2 heifers 〃 〃 〃	21	10	0
〃	20	〃 expenses of drover (cash) £1 2 6			
〃	20	〃 my own expenses 〃 0 16 6			
			1	19	0
〃	20	Sold C. Evans 12 porkers at £2, 10*s.*	30	0	0
〃	23	Received C. Evans's cheque	30	0	0
〃	24	Paid C. Evans's cheque to bank	30	0	0
〃	30	〃 for household and personal expenses for the month (cash)	12	10	0
May	2	〃 wages for two weeks	17	10	0
〃	4	〃 J. Morris & Co. for bone meal (cheque)	15	0	0
〃	4	Purchased grass and clover seeds for 40 acres from Sutton & Co.	28	0	0
〃	16	Paid wages for two weeks	18	5	0
〃	16	Sold 70 sheep to J. Nash	130	0	0
June	1	Sutton & Co. for seeds, £26, 12*s.* (cheque)	26	12	0
〃	1	〃 allowed £1, 8*s.* discount	1	8	0
〃	1	Drew from bank	60	0	0
〃	1	Purchased 10 tons superphosphate from Griffin & Co. at £3	30	0	0
〃	15	Paid Griffin & Co. (cheque)	15	0	0
Oct.	24	Bought 50 lambs of James Smith	70	0	0
Nov.	1	Paid rent for half-year	202	10	0
〃	12	Sold 80 tons potatoes to A. Brown at £3	240	0	0
〃	24	〃 270 quarters wheat to Greenwood & Co. at 35*s.*	472	10	0
〃	29	Received Greenwood & Co.'s cheque and paid it into bank	472	10	0
〃	29	Purchased 2 tons Bombay cotton cake from J. Morris & Co. at £4, 10*s.*	9	0	0
〃	29	〃 8 tons basic slag from Griffin & Co. at 50*s.*	20	0	0
〃	29	Sold J. Cresswell 4 tons hay at £4	16	0	0
Dec.	7	Bought 2 tons linseed cake from J. Morris & Co. at £8	16	0	0
〃	7	Received A. Brown's cheque and paid it into bank	240	0	0
〃	18	Paid J. Morris & Co. (cheque)	25	0	0
〃	18	Sold 6 bullocks to J. Nash	122	0	0
〃	18	Paid expenses of sale and carriage of bullocks	3	10	0
〃	18	Sold 20 tons of carrots at £4 to J. Corner	80	0	0
〃	26	Received cash of J. Corner	80	0	0
1908.					
Jan.	2	Paid for repairs to implements	6	0	0
〃	2	Sold 10 pigs to J. Cresswell at £4, 10*s.*	45	0	0
〃	9	Paid insurance premium	3	10	0
〃	20	Sold 40 quarters wheat to Greenwood & Co. at 34*s.*	68	0	0
〃	20	Received J. Cresswell's cheque and paid it into bank	61	0	0
〃	27	〃 Greenwood & Co.'s cheque	68	0	0
〃	27	Sold 20 tons potatoes to A. Brown at £4	80	0	0
〃	29	Paid Greenwood & Co.'s cheque to bank	68	0	0
〃	29	Sold 30 sheep to J. Cresswell	60	0	0

there. It is by studying the interest of one's labourers in little points like this that the good feeling arises between master and man.

In the first column it will be seen that the amount of wages paid per week to the several labourers is given; in the next column we have the labourers' names, or, where their occupation is a settled one, the occupation instead of the name. The next six small columns are headed by the days of the week, commencing with Saturday, because we assume the wages to be paid on Friday; the remaining money-columns, which are numbered and headed by the names of the crops cultivated on the farm, are to receive the amount spent for labour among the several crops, according to the proportion of work done for the benefit of each. The farmer is here represented as cultivating wheat, clover, carrots, mangels, potatoes, and turnips, to each of which a column is assigned; but as there are expenses for labour attached to horses, and the cattle, sheep, and pig stocks, each of these also has a separate column; and as many expenses, such as repairs to farm roads or ditching, cannot be charged under any of the above heads, being incurred equally, or nearly so, for the benefit of the whole, a separate column is set apart for such expenses, entitled General Account. The number of columns required will depend upon the variety of crops grown and of stock kept on the farm. In many cases those given here for carrots and potatoes may

MOUNT FARM LABOUR ACCOUNT, *for Week ending* 11*th April*, 1907

Weekly Wages.		Sat.	Mon.	Tues.	Wed.	Thur.	Fri.	No. 1, Wheat.	No. 2, Clover.	No. 3, Carrots.	No. 4, Mangels	No. 5, Potatoes	No. 6, Turnips.	No. 7, Horses.	No. 8, Cattle.	No. 9, Sheep.	No. 10, Pigs.	No. 11, General.	No. 12.	TOTAL.	OBSERVATIONS.
s.								£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	
17	1st Ploughman...	1	1	1	1	6	6	0 11 4	...	...	...	...	0 5 8	...	...	...	...	...	...	0 17 0	
15	2nd ,, ...	4	8	1	6	6	6	0 2 6	...	...	0 2 6	...	0 7 6	...	0 2 6	...	...	...	...	0 15 0	
15	3rd ,, ...	7	1	4	1	6	6	0 5 0	...	...	0 2 6	...	0 5 0	0 2 6	...	...	...	...	...	0 15 0	
12	4th ,, ...	8	9	1	1	4	1	0 6 0	...	...	0 2 0	...	...	...	0 2 0	0 2 0	...	...	...	0 12 0	
14	Cowman	8	8	8	8	8	8	...	...	...	...	...	...	...	0 14 0	...	...	...	...	0 14 0	
5	His Boy...........	11	11	11	11	11	11	...	...	...	...	...	...	...	...	...	...	0 5 0	...	0 5 0	
14	Shepherd	9	9	9	9	9	9	...	...	...	...	...	...	...	...	0 14 0	...	...	...	0 14 0	
5	W. Stanly..........	10	10	10	10	10	10	...	...	...	...	...	...	...	...	...	0 5 0	...	...	0 5 0	
5	C. Massy..........	9	10	9	10	9	10	...	...	...	...	...	...	...	...	0 2 6	0 2 6	...	...	0 5 0	
5	B. Smith	9	9	1	1	8	8	0 1 8	...	...	...	...	...	...	0 1 8	0 1 8	...	...	...	0 5 0	
8	J. Paine...........	8	8	8	8	8	8	...	...	...	...	...	...	...	0 8 0	...	...	...	...	0 8 0	
5	D. Paine..........	8	8	8	10	10	10	...	...	...	...	...	...	...	0 2 6	...	0 2 6	...	...	0 5 0	
8	J. Clark...........	4	4	4	6	6	6	...	...	...	0 4 0	...	0 4 0	...	...	...	...	...	...	0 8 0	
12	J. Rumbolds......	...	4	1	1	...	6	0 4 0	...	...	0 2 0	...	0 2 0	...	...	...	...	...	...	0 8 0	
12	C. Cook	4	11	1	1	1	4	0 6 0	...	...	0 4 0	...	...	...	...	...	...	0 2 0	...	0 12 0	* Absent, owing to illness, all the week.
12	H. Cook...........	4	11	4	1	1	1	0 6 0	...	...	0 4 0	...	...	...	...	...	...	0 2 0	...	0 12 0	
12	J. Ball.............	4	11	...	4	1	6	0 2 0	...	...	0 4 0	...	0 2 0	...	...	...	...	0 2 0	...	0 10 0	
14	T. Burford........	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Carried forward							2 4 6	...	...	1 5 0	...	1 6 2	0 2 6	1 10 8	1 0 2	0 10 0	0 11 0	...	8 10 0	
Horses.	Brought forward																				
	Carried forward																				

MOUNT FARM LABOUR ACCOUNT, *for Week ending 18th April*, 1907

Weekly Wages.		Sat.	Mon.	Tues.	Wed.	Thur.	Fri.	No. 1, Wheat.	No. 2, Clover.	No. 3, Carrots.	No. 4, Mangels	No. 5, Potatoes	No. 6, Turnips.	No. 7, Horses.	No. 8, Cattle.	No. 9, Sheep.	No. 10, Pigs.	No. 11, General.	No. 12.	TOTAL.	OBSERVATIONS.
s.								£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
	Brought forward							2 4 6	...	...	1 5 0	...	1 6 2	0 2 6	1 10 8	1 0 2	0 10 0	0 11 0	...	8 10 0	WAGES PAID.
17	1st Ploughman...	6	4	8	4	4	4	...	...	...	0 11 4	...	0 2 10	...	0 2 10	...	...	...	...	0 17 0	1 14 0
15	2nd „ ...	6	4	8	4	4	4	...	...	...	0 10 0	...	0 2 6	...	0 2 6	...	...	...	...	0 15 0	1 10 0
15	3rd „ ...	6	4	9	4	4	4	...	...	...	0 10 0	...	0 2 6	...	...	0 2 6	...	...	...	0 15 0	1 10 0
12	4th „ ...	4	4	6	6	4	6	...	...	..	0 6 0	...	0 6 0	...	...	...	...	...	...	0 12 0	1 4 0
14	Cowman..........	8	8	8	8	8	8	...	...	...	...	...	...	...	0 14 0	...	...	...	...	0 14 0	1 8 0
5	His Boy..........	11	11	11	11	11	11	...	...	...	...	...	...	...	...	...	...	0 5 0	...	0 5 0	0 10 0
14	Shepherd..........	9	9	9	9	9	9	...	...	...	...	...	...	...	...	0 14 0	...	...	...	0 14 0	1 8 0
5	W. Stanly..........	9	9	9	9	9	9	...	...	...	...	...	...	...	...	0 5 0	...	...	...	0 5 0	0 10 0
5	C. Massy..........	10	10	10	10	10	10	...	...	...	...	...	...	...	...	...	0 5 0	...	...	0 5 0	0 10 0
5	B. Smith..........	10	10	10	10	10	10	...	...	...	...	...	...	...	...	...	0 5 0	...	...	0 5 0	0 10 0
8	J. Paine..........	8	8	8	8	8	8	...	...	...	...	...	...	...	0 8 0	...	...	...	...	0 8 0	0 16 0
5	D. Paine..........	10	10	10	10	10	10	...	...	...	...	...	...	...	...	...	0 5 0	...	...	0 5 0	0 10 0
8	J. Clark..........	8	8	8	8	8	8	...	...	...	...	...	...	...	0 8 0	...	...	...	...	0 8 0	0 16 0
12	J. Rumbolds......	6	6	6	5	5	5	...	...	...	...	0 6 0	0 6 0	...	...	...	...	...	...	0 12 0	1 0 0
12	C. Cook..........	4	4	4	4	6	6	...	...	...	0 8 0	...	0 4 0	...	...	...	...	...	...	0 12 0	1 4 0
12	H. Cook..........	4	4	4	4	6	6	...	...	...	0 8 0	...	0 4 0	...	...	...	...	...	...	0 12 0	1 4 0
12	J. Ball..........	4	4	4	4	6	6	...	...	...	0 8 0	...	0 4 0	...	...	...	...	...	...	0 12 0	1 2 0
14	T. Burford........	11	11	11	11	11	11	...	...	...	...	...	...	...	...	...	...	0 14 0	...	0 14 0	0 14 0
	Carried forward							2 4 6	...	...	4 6 4	0 6 0	2 18 0	0 2 6	3 6 0	2 1 8	1 5 0	1 10 0	...	18 0 0	18 0 0
Horses.	Brought forward																				
	Carried forward																				

be dispensed with, and others may have to be introduced for, say, oats, barley, or dairy. By way of explanation, we add, in reference to the columns for the days of the week, that the numbers in them opposite each labourer refer to those at the head of the money-columns. In the case of the first ploughman, they denote that he was employed the first four days of the week in labour that was connected with and for the benefit of the wheat crop, whilst the last two days he was so engaged for the turnip crop the second ploughman, again, on Saturday was working in connection with the mangel crop, No. 4; on Monday he was carting swedes all day for the cattle, No. 8; on Tuesday his work was on account of wheat, No. 1; and during the rest of the week, of turnips, No. 6. It will be as well here to remark that, on keeping these accounts for the first year, the farmer should furnish himself with a list of abbreviations to place above the figures inserted in these columns, so that he may know how the labour was employed as well as for what crop. This should be done in a general way in the memorandum book, but particularly, so far as each man is concerned, it should be done here. After the first year, however, he will know all this almost to a certainty without any such assistance, by merely referring to the date of the labour account—the season being a sufficient guide. That there may be no mistake, the letter *t.* might be put above the fig. 1 for thrashing, *h.* for hoeing, *p.* for ploughing, &c. As regards the labourers, we see the cowman was employed all the week for No. 8, the cattle; the shepherd for No. 9, sheep; the boys were principally assisting the cowman for No. 8, and the shepherd for No. 9, as well as for the pigs, No. 10; the men were engaged for No. 4, viz. in turning manure for the mangel crop, and for No. 11, working in the garden; and so on.

These entries should be made every evening, when the work of the day is over; and if the farmer's engagements are such that he is necessarily from home, the foreman should keep this book, and on the pay-day at noon, after putting down the work of the labourers during the afternoon, he should bring the book to the farmer's house, that he may calculate the amount of wages due each labourer, in time for the evening payment. This is an easy process, and takes up little time; the number of days' work is recorded against each, and the daily wage is known. After the payment of wages, the amount received by each labourer has to be divided amongst the several columns numbered against him for the week. On the line of the first ploughman, who receives 2*s.* 10*d.* per day, 11*s.* 4*d.*, the wage of four days, is charged in No. 1 column, and 5*s.* 8*d.*, the wage of the other two, is entered in No. 6. Take again the case of J. Ball, the last of the labourers. On Saturday he was working under No. 4, and running the eye along the other days we find that on Wednesday he was also so engaged; for two days at 2*s.* per day (12*s.* per week), 4*s.* is therefore entered to the mangel crop; on Monday, for No. 11, 2*s.* is therefore put to the general account; Tuesday, absent; Wednesday, already noted; Thursday, No. 1, 2*s.*; and Friday, 2*s.*, No. 6. On adding up the sums by running the eye along the line, we enter as the total 10*s.*, which was paid him for the week. In this case the labourer has been engaged almost every day at a different occupation. This will not be found to be generally the case, but even were it so, half an hour would suffice to make all the calculations necessary to divide the whole expense of the labour among the proper crops. At the bottom of the money-columns a space is left to add up the sums expended on each crop during the week: in this case £2, 4*s.* 6*d.* was spent for the benefit of the wheat crop, £1, 5*s.* for the mangel, and so on; and if the farmer paid his workmen once a week, he has merely to look at the last column and he sees the amount due to each. If, however, as in this case, he should pay the labourers once a fortnight, he must turn the leaf and carry these sums to the head of the next page, and proceed as formerly, taking care to add these sums to the ensuing week's dues. At the end of the fortnight, by adding the 'Total' columns of the two weeks together (the result he can enter under the head of Observations), he has the amount due to each labourer for the fortnight's labour, and these added up should of course agree with the column 'Total'. To avoid the possibility of omitting any of the former week's payments, it is as well to run the eye along the bottom line of the columns to see if their total agrees with the whole sum paid.

We have thus, instead of upwards of one hundred distinct payments to different labourers for different work, to take notice of only nine during the fortnight: viz., £2, 4*s.* 6*d.* for wheat, £4, 6*s.* 4*d.* for mangels, 6*s.* for potatoes, £2, 18*s.* for turnips, 2*s.* 6*d.* horse stock, £3, 6*s.* cattle, £2, 1*s.* 8*d.* sheep stock, £1, 5*s.* for pig stock, and £1, 10*s.* for general account. While in the memorandum book we insert, '18th April, Paid wages past fortnight, see Labour Book, £18.

At the bottom of the sheet there is a space left for horses, to enable the farmer, by entering the number of days of horse-labour which have been expended for the benefit of each crop, to ascertain the proper proportion in which to charge each crop for the expense of the horses during the year. This is ascertained at the end of the year by dividing the whole of the expenses of horse keep among the different crops according to their proportion of labour. This proportion, however, varies so little that after the first year it is almost unnecessary to continue keeping the record of it.

After this lengthened explanation of the Labour Book, which its importance fully warrants, we proceed to the next, the *Cash Book*. In this book the entries taken from the Memorandum Book are carefully entered, so that everything connected with the transaction is communicated at first sight. As most important payments are now made by means of cheques, the Cash Book provides columns for the separate entry of actual cash transactions, and of payments and receipts through the bank, in addition to those for date and particulars of the transaction, and the page or folio of the ledger to which the entry is finally transferred. A folio of this book is given on p. 28, and from the entries there it will be seen that receipts are entered on the debtor or left-hand side. All these, whether of cash or cheques, are entered in the cash column. Payments are entered on the credit or right-hand side—if in cash, in the cash column, but if by cheque, in the bank column. When cash or cheques are paid into the bank, entries are made on both sides of the Cash Book, for the transaction is a payment of cash, and a receipt by the bank. Similarly, when a cheque is drawn payable to 'self', the result is a payment by the bank and a receipt of cash. This must therefore be entered in both the bank column on payments side, and the cash column on receipts side. The Cash Book thus furnishes a clear statement of all money transactions, and of the balance of cash in hand and at the bank.

The *Day Purchases Book* and *Sales Book* are for the purpose of furnishing a record of the credit purchases and sales. When the credit transactions are few in number it is possible to keep satisfactory accounts without these books; the transactions do not then appear in the systematic accounts until payment is made or taken; until this takes place they are merely recorded in the Memorandum Book. The average farmer finds these books useful, however, and if a considerable trade of a retail character is carried on they are practically essential. Suitable forms for these books are given on page 29. The Purchases Book contains columns in addition to those for date, name and particulars, amount, and the number of the Ledger folio to which the item is posted, one for the invoice number, which enables the invoice relating to any particular transaction to be readily found and consulted, and analysis columns headed by the names of the common purchases. When invoices are received they should be carefully examined to ascertain that the details are correctly stated, the particulars should then be entered in the Purchases Book, the invoices numbered and filed, and the number inserted in the column provided for the purpose. The amounts can be carried to the proper analysis columns at any convenient opportunity. The Sales Book has a ruling similar to that of the Purchases Book, but the headings of the analysis columns are appropriate for the stock or crops usually sold. Entries are made in it from the Memorandum Book as credit sales occur. Purchases and sales for cash are not entered in the Day Books.

The *Journal* is employed to receive and arrange in Debtor and Creditor form a few transactions which do not affect cash and are not purchases or sales. Such items are discounts allowed or received and interest charged on capital. The Journal is also useful for arranging the adjusting entries between the various accounts at the close of the year, when it is desired to ascertain the actual profit or loss on each. The rule to be observed in Journalizing, and, in fact, in making all bookkeeping entries, is that the account which receives is Debtor and that which gives is Creditor. It is sometimes difficult, as in the case of discounts received or allowed, or of interest charged, to see readily which account does receive, and in these cases the rule that losses are debited may be helpful. The items are posted to the corresponding sides of Ledger accounts.

The object of the *Ledger* is to collect and arrange the various transactions under their proper heads—a separate account being opened for each class of transactions, as for each of the different kinds of crop cultivated, or stock kept; so that at the end of the year each account will contain the whole of the transactions relating to it, whether these have been expenses for the benefit of the crop, or results accruing in the produce of the crop. These are arranged on either side of the folio, or open leaf, and are termed the Debtor and Creditor sides of the account; and a comparison of the totals of these sides, of course, determines whether the transactions of that particular account have been profitable or otherwise. The term Debtor means one who owes money or who is indebted for something, and the term Creditor is one to whom money or a debt of some kind is due. These terms are correctly applicable to a farmer's accounts. For payments on behalf of a crop, the crop is indebted, and these are entered on the Debtor or Dr. side in the ledger account of the crop. Similarly, for the results of sales of the crop someone is indebted to the crop, which is thus Creditor; the crop account is therefore credited with the amount, that is, the entry is made on its Creditor or Cr. side.

The number of accounts in the ledger will depend mainly on the farmer himself. If he wishes to keep the number as few as possible, the whole of the root crops may be included in one account, and all the grain crops in another; in which case the same course might be adopted with the Labour Book and the Sales and Purchases Books, two columns there serving for all the root and grain crops. In the case we are describing, in addition to accounts for the persons with whom there are credit transactions, there will be accounts for Capital invested in the farm, Wheat, Clover, Carrots, Mangels, Potatoes, Horses, Cattle, Sheep, Pigs, Implements, Manures, Feeding-stuffs, Rent, Taxes and Insurance, General Expenses, and Household and Personal Expenses. It will be observed in the Ledger that several of the crops have two accounts. Wheat and some others have an account for 1907 and one for 1908. The object for this division is to ascertain the profit on any one year's crop. It will often happen that before the crop of 1907 has been realized certain expenses will have been incurred on the 1908 crop. The desire being to keep these years separate, two accounts are opened, and to each year is debited or credited, as the case may be, the expenses and the realizations. When the 1907 crop has been finally disposed of, the balance is transferred to the Profit and Loss Account. The Household and Personal Expenses Account has, strictly speaking, no connection with the accounts of the farm. Other business men 'draw' cash for private use, but farmers rarely keep their private and business moneys separate, with the result that they have no knowledge of the amount of their expenditure for purposes unconnected with their farm. Business men without private means live, of course, on the profits of their business, but farmers are apt to look upon their profits as being only what is left after the expenses of living have been defrayed: and it no doubt often happens that one thinks of his farm as an unprofitable business, because he has a difficulty in meeting his liabilities, when there is, in fact, a substantial profit of which he is unaware, because he keeps no accounts to tell him of it, and his personal expenses are much in excess of his estimate of them. After a few remarks on the Inventory of Stock at the close of the year, we shall proceed to give an example of the mode of working the Cash Book, Sales and Purchases Books, Journal, and Ledger, by copying a few pages from the form we recommend.

It will be remembered that the farmer was supposed to have taken possession of a farm already furnished, so to speak, paying his predecessor the full market value of all his stock and cultivation. He then prepared a Balance Sheet, as shown in the example on p. 27, stating the value of his various assets and their total value. Now, at the end of the year, he must just consider himself in the position which he replaced when he took possession; he must ascertain the market value of all his stock—what he could sell were he to leave the farm at that time. To do this equitably he may procure the assistance of some friend on whose judgment he can rely, or of some valuer accustomed to such work. This, however, is not essential. Every farmer ought to be able to make a fair valuation of the stock and crops of his farm. In the case of an evenly-stocked farm there is little to be urged against the practice of valuing live stock of the same class and age at the same amount per head each year. Implements and machinery need not be valued annually. If they are well cared for, and the cost of new stock purchased during the year be added to the previous value, a reduction of 10 per cent for wear will result in most cases in a very close approximation to the value. The value thus obtained should be entered in an Inventory, and thence transferred, as if received, to its appropriate place in the various accounts which it concerns; to the credit side, of course, of those which are being closed for the past year, for it is a payment by them into the farmer's pocket; and to the debtor side of those which are being opened for the year to come, for it is as if immediately invested again for *their* benefit.

The following statement shows the form in which the Inventory, at the end of each year, of the stock then on the farm, should be drawn up so as to balance the accounts and enable a Balance Sheet to be prepared.

The Cash Book, Day Books, and Ledger should be written in a clear, bold hand. When opening his books the farmer must refer to his Balance Sheet. The assets are entered each on the Dr. side of its proper account in the Ledger, and the liabilities on the Cr. side.

Having made all the entries to the proper ledger accounts from the Balance Sheet, we now proceed to carry a set of transactions through the various books. These are the Cash Book, Purchases Book, Sales Book, Journal, and Ledger. It is most important that all entries be correctly made. The details of these transactions are to be found in the Memorandum Book on p. 20.

The farmer having just taken the farm in this instance, practically all his entries are for purchases. In making the entries we refer to the Memorandum Book. The sum of £1081, 3*s.* 8*d.* in bank and £10 retained in hand represents the *balance* of cash after paying for the assets taken over on entering the farm. These sums are entered on the receipts side of Cash Book, in the bank and cash columns respectively. The other entries call for no explanation beyond directing attention to the fact that the cash drawn from bank on April 18th is entered on both sides, because the balance at bank is reduced by £30 and the cash in hand is increased by that amount. Again, Evans's cheque is entered at the time of receipt in the cash receipts column, and when paid into the bank is again entered, this time on both sides.

In the Ledger, which we proceed to describe,

An Inventory of Live and Dead Stock, on Mount Farm, which I have this day purchased from the outgoing Tenant, C. A. Jones, and paid for by cheque.

1st April, 1907.

			£ s. d.	£ s. d.
Horses ...	A riding horse, fit for farm work, with saddle and bridle		32 0 0	
	No. 1 pair, Tom	£35 0 0		
	Bob	30 0 0		
			65 0 0	
	No. 2 pair, Captain	30 0 0		
	Charlie	22 0 0		
			52 0 0	
	No. 3 pair, Stirling (old)...	12 0 0		
	Smart	18 0 0		
			30 0 0	
	No. 4 pair, Music	21 10 0		
	Colonel	21 0 0		
			42 10 0	
	Carry forward			221 10 0

		£	s.	d.	£	s.	d.
	Brought forward				221	10	0
Implements	Harness, four pair cart and plough harness (old and worn) ...	24	0	0			
	Corn chest ...	0	7	0			
	4 ploughs with draught-trees ...	9	7	0			
	7 carts, old and worn ...	49	0	0			
	7 framed carts for harvest ...	28	10	0			
	A gig ...	20	0	0			
	Roller ...	8	10	0			
	Turnip drill (old) ...	3	0	0			
	2 cultivators ...	16	0	0			
	5 horse-hoes and drill-harrows ...	16	10	0			
	4 pair iron harrows and draught-trees ...	12	0	0			
	One pair of seed harrows ...	1	10	0			
	Iron rake, cart jack, &c. ...	1	6	0			
	Grass and clover seed sowing machine ...	2	10	0			
	Potato washers ...	4	0	0			
	Potato steamer and apparatus ...	12	0	0			
	38 corn staddles and wooden rails ...	38	0	0			
	Chaff machine and fittings ...	10	0	0			
	Corn crusher ...	10	10	0			
	Fanner and 7 sieves ...	4	15	0			
	2 large pickling tubs ...	1	0	0			
	120 sacks, at 1*s*. ...	6	0	0			
	Weighing machine and weights ...	4	0	0			
	Bushel and roller ...	0	10	0			
	Sack barrow, shovels, &c. ...	1	0	0			
					284	5	0
Cattle ...	A cow (red) ...	12	0	0			
	A cow (roan) ...	12	0	0			
	4 two-year-old steers ...	60	5	0			
	A hay-cutting knife ...	0	3	6			
	Iron stall chains ...	3	10	0			
	Barrows, baskets, and forks ...	2	0	0			
					89	18	6
Sheep Stock	100 wethers ...	157	10	0			
	A cake crusher ...	7	0	0			
	4 turnip cutters ...	10	0	0			
	Sheep nets and stakes ...	5	0	0			
					179	10	0
Pig Stock ...	Sow and 3 pigs (black) ...	4	10	0			
	White sow and 2 pigs ...	5	10	0			
	Spotted sow and 7 pigs ...	6	10	0			
	11 breeding sows ...	34	10	0			
	22 porkers ...	40	0	0			
	A boar ...	5	10	0			
	Iron trough ...	0	15	0			
	10 earthenware troughs ...	5	0	0			
					102	5	0
Wheat ...	Value of cultivation in Nos. 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 fields, 140 acres, at 12*s*., as under:— Once ploughed ... 8*s*. per ac. Three times harrowed, at 8*d*. ... 2*s*. ,, Drilling ... 2*s*. ,, — 12*s*.	84	0	0			
	Seed, 280 bushels, at 4*s*. (2 bushels per acre) ...	56	0	0			
					140	0	0
Wheat ...	Half the cultivation and manure expended the previous year on land when in roots, that quantity being assumed as still remaining in the land (100 acres at £4) ...	400	0	0			
	Value of manure dropped by sheep on 40 acres of land under clover the previous year ...	40	0	0			
					440	0	0
Clover	Seed sown in Nos. 2, 8, 14, and 20 fields, 40 acres ...	......			25	5	0
Turnips ...	Cultivation up to this date, for benefit of this crop ...	......			8	0	0
Carrots ...	Cultivation up to this date; ploughing and harrowing ...	......			11	12	0
Potatoes ...	Cultivation; ploughing and harrowing ...	16	0	0			
	Seed potatoes in barn, 104 sacks at 5*s*. ...	26	0	0			
					42	0	0
Mangels ...	Cultivation; ploughing and harrowing ...	......			14	0	0
Manures ...	Unexhausted manure value of feeding-stuffs consumed on the farm	......			136	9	0
Gen. Acct. ...	Straw ...	20	0	0			
	Few shrubs in garden ...	4	1	10			
					24	1	10
					1718	16	4

From this Inventory the following Balance Sheet would be prepared and would include the Cash in bank and on hand.

BALANCE SHEET AS AT 1ST APRIL, 1907

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Capital	2810	0	0	Wheat—(1) Cultivation in fields, as per Inventory	140	0	0
				(2) Half the cultivation and manure on roots, 100 acres, per Inventory	440	0	0
				Clover, seed sown in fields, per Inventory	25	5	0
				Turnips, cultivation to date, "	8	0	0
				Carrots, " "	11	12	0
				Potatoes: cultivation, ploughing, and hoeing, per Inventory	42	0	0
				Mangels: cultivation, ploughing, and hoeing, per Inventory	14	0	0
				Manures, unexhausted manure, per Inventory	136	9	0
				General account: straw and shrubs, per Inventory	24	1	10
				Cattle, as per Inventory	89	18	6
				Sheep, "	179	10	0
				Pigs, "	102	5	0
				Horses, "	221	10	0
				Implements, "	284	5	0
				Cash in bank, ... £1081 3 8			
				" hand, ... 10 0 0	1091	3	8
	2810	0	0		2810	0	0

the debtor and creditor sides of the account are entered on the different sides of the folio.

We do not particularize in the ledger, but merely enter in one line, as tersely as possible, the fact of payment, or receipt, as it may be, referring (in the column immediately before the money column) to the page in the Cash Book or Day Book where the entry was made, for all particulars connected with the transaction. All payments entered in the Cash Book are transferred or posted to the Dr. side of their respective ledger accounts, and all receipts to the Cr. side. Each money transaction affects either cash or bank account and one other account. Whenever cash is received or paid, some account gives or receives value; two entries are thus required for each transaction, one in the Cash Book and one on the opposite side in the ledger account concerned. This is accomplished by first making the entry in the Cash Book and afterwards posting it in the way we have described. Cash purchases or sales are posted to the accounts which received or supplied the things paid for. In transactions of this kind the name of the person traded with need not be entered in the Cash Book. Payments or receipts for goods or stock entered in the Day Books must be posted to the persons' accounts in the Ledger. We shall now ledgerize all the transactions that have been inserted in the Cash Book, so that the mode of working may be seen.

When posting items to the ledger the rule to be observed is that payments are posted to the Dr. side and receipts to the Cr. side. The first items to be entered are, as previously stated, the liabilities and assets from the Balance Sheet. An account is opened, each on a separate folio, for each of these. The Cash Book entries are next dealt with in order. After having entered an amount we place in the folio column of the Cash Book the number of the Ledger folio to which the amount has been posted. The number of the Cash Book folio is also inserted in the Ledger folio column. By means of these folio numbers the origin of any ledger entry can be readily found or the posting of an entry be traced in the Ledger. We need not describe any further entries in words, but may remark that as the Cash Book contains the cash account and bank account, transactions which affect these accounts only are not posted. Such transactions are payments of cash or cheques into bank, and the cashing of cheques payable to 'self'. When dealing with entries recording the payment of wages, the Labour Book must be referred to, and the amounts at the foot of the columns posted to their proper accounts. The total of these amounts is, of course, the sum entered in the cash book.

The Day Book entries are posted in a similar manner, the amounts in the Purchases Book to the credit of the persons' accounts, and those in the Sales Book to their debit. The amounts in the analysis columns are not necessarily posted until the end of the year, when their totals are transferred, those from the Purchases Book to the Debtor side, and those from the Sales Book to the Creditor side of their respective accounts, the names of which appear at the heads of the columns. The double entry is thus obtained without the trouble of posting each item twice, except in the case of entries in the *Miscellaneous* column. A note is made at the foot of the page showing the accounts to which the latter are to be transferred and the amounts. We now proceed to make the entries in proper form.

CASH BOOK

Dr.

Date.	Receipts.	Folio.	Cash. £	s.	d.	Bank. £	s.	d.
1907								
April 1	To balance at bank	...	......			1081	3	8
" 1	" balance, cash in hand	...	10	0	0			
" 18	" bank	...	30	0	0			
" 23	" C. Evans	37	30	0	0			
" 24	" cheque paid to bank	...	......			30	0	0
June 1	" bank	...	60	0	0			
Nov. 29	" Greenwood & Co.	29	472	10	0			
" 29	" bank	...	......			472	10	0
Dec. 7	" A. Brown	30	240	0	0			
" 7	" bank	...	......			240	0	0
" 26	" J. Corner	31	80	0	0			
1908								
Jan. 20	" J. Cresswell	26	61	0	0			
" 20	" bank	...	......			61	0	0
" 27	" Greenwood & Co.	29	68	0	0			
" 29	" bank	...	......			68	0	0
	" other receipts during the year:							
	Cattle ...	...	350	0	0			
	Sheep ...	...	1020	0	0			
	Pigs ...	...	34	0	0			
	Cheques paid into bank	...	......			1404	0	0
	Cash drawn from bank	...	750	0	0			
			3205	10	0	3356	13	8

Cr.

Date.	Payments.	Folio.	Cash. £	s.	d.	Bank. £	s.	d.
1907								
April 3	By expenses at —— market	21	0	2	6			
" 11	" J. Cullimore	36	4	15	0			
" 17	" feed-measures for stable	17	0	5	0			
" 18	" bank	...	......			30	0	0
" 18	" wages for two weeks, as per Labour Book	...	18	0	0			
" 20	" 7 bullocks purchased at Stow Fair	14	......			74	7	6
" 20	" 2 heifers purchased at Stow Fair	14	......			21	10	0
" 20	" expenses of drover at Stow Fair	14	1	2	6			
" 20	" expenses of self at Stow Fair	14	0	16	6			
" 24	" bank	...	30	0	0			
" 30	" household and personal expenses for the month	22	12	10	0			
May 2	" wages for two weeks	...	17	10	0			
" 2	" J. Morris & Co.	33	......			15	0	0
" 16	" wages for two weeks	...	18	5	0			
June 1	" Sutton & Co.	34	......			26	12	0
" 1	" bank	...	......			60	0	0
" 15	" Griffin & Co.	35	......			15	0	0
Nov. 1	" rent for half-year	25	......			202	10	0
" 29	" bank	...	472	10	0			
Dec. 7	" "	...	240	0	0			
" 18	" J. Morris & Co.	33	......			25	0	0
" 18	" expenses, sale of bullocks	14	3	10	0			
1908								
Jan. 6	" repairs to implements	19	6	0	0			
" 9	" insurance premium	25	3	10	0			
" 20	" bank	...	61	0	0			
" 29	" "	...	68	0	0			
	" other payments during the year:							
	Horse ...	...	......			25	0	0
	Sheep ...	...	......			700	0	0
	Cattle ...	...	......			350	0	0
	Feeding-stuffs	...	......			220	0	0
	Manures	...	......			140	0	0
	Seeds ...	...	......			28	2	6
	Wages ...	...	410	0	0			
	Rates and Taxes	25	......			35	0	0
	General expenses	21	26	0	0			
	Household and personal expenses	22	210	0	0			
	Cheques paid to bank	...	1404	0	0			
	Cash drawn from bank	...	......			750	0	0
	" Balance at this date	...	197	13	6	638	11	8
			3205	10	0	3356	13	8

PURCHASES BOOK

Date.	Name and Particulars.	Fo.	In.	Amount.	Manures.	Feeding-stuffs.	Cattle.	Sheep.	Miscellaneous.
1907.				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
	J. Morris & Co.	33							
April 3	4 tons steamed bone meal ...			15 0 0	15 0 0				
	J. Cullimore	36							
" 3	1 ton potatoes at £4, 15*s*. per ton			4 15 0					4 15 0
	Sutton & Co.	34							
May 4	Grass and clover seeds			28 0 0					28 0 0
	Griffin & Co.	35							
June 1	10 tons superphosphate at £3 ...			30 0 0	30 0 0				
	Jas. Smith	27							
Oct. 24	50 lambs			70 0 0				70 0 0	
	J. Morris & Co.	33							
Nov. 29	2 tons Bombay cake at £4, 10*s*. ...			9 0 0		9 0 0			
	Griffin & Co.	35							
" 29	8 tons basic slag at 50*s*. per ton ...			20 0 0	20 0 0				
	J. Morris & Co.	33							
Dec. 7	2 tons linseed cake at £8 per ton			16 0 0		16 0 0			
	Other purchases during the year:								
	Horse			25 0 0					25 0 0
	Sheep			700 0 0				700 0 0	
	Cattle			350 0 0			350 0 0		
	Feeding-stuffs			220 0 0		220 0 0			
	Manures			140 0 0	140 0 0				
	Seed			28 2 6					28 2 6
				1655 17 6	205 0 0	245 0 0	350 0 0	770 0 0	85 17 6

Analysis of Miscellaneous Column:—Horse a/c, £25; Potatoes a/c, £4, 15*s*.; Clover a/c, 1908, £28; Oats a/c, 1908, £28, 2*s*. 6*d*. ... ... = £85 17 6

SALES BOOK

Date.	Name and Particulars.	Fol.	Amount.	Cattle.	Sheep.	Pigs.	Potatoes.	Miscellaneous.
1907.			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
	C. Evans	37						
April 20	12 porkers at £2, 10*s*. each ...		30 0 0			30 0 0		
	J. Nash	28						
May 16	70 sheep		130 0 0		130 0 0			
	A. Brown	30						
Nov. 12	80 tons potatoes at £3 per ton ...		240 0 0				240 0 0	
	Greenwood & Co.	29						
" 24	270 qrs. wheat at 35*s*. per quarter		472 10 0					472 10 0
	J. Cresswell	26						
" 29	4 tons hay at £4 per ton		16 0 0					16 0 0
	J. Corner	31						
Dec. 18	20 tons carrots at £4 per ton . .		80 0 0					80 0 0
	J. Nash	28						
" 18	6 bullocks		122 0 0	122 0 0				
1908.	Greenwood & Co.	29						
Jan. 20	40 qrs. wheat at 34*s*. per quarter		68 0 0					68 0 0
	J. Cresswell	26						
" 20	10 pigs at £4, 10*s*. each		45 0 0			45 0 0		
	A. Brown	30						
" 27	20 tons potatoes at £4 per ton ...		80 0 0				80 0 0	
	J. Cresswell	26						
" 29	30 sheep at £2 each		60 0 0		60 0 0			
	Other sales during the year:—							
	Cattle		350 0 0	350 0 0				
	Sheep		1020 0 0		1020 0 0			
	Pigs		34 0 0			34 0 0		
			2547 10 0	472 0 0	1210 0 0	109 0 0	320 0 0	636 10 0

Analysis of Miscellaneous Column:—Wheat (1907) a/c, £540, 10*s*.; Clover (1907) a/c, £16; Carrots a/c, £80 ... ... = £636 10 0

	JOURNAL		Dr.			Cr.		
1907.		Folio.	£	s.	d.	£	s.	d.
June 1	Sutton & Co. ... Dr.	34	1	8	0			
	To Discount ...	23				1	8	0
1908.								
March 31	Interest (Year Interest on Capital) Dr.	24	140	10	0			
	To Capital ...	1				140	10	0
" 31	Horses ... Dr.	17	85	0	0			
	To Clover (feed) ...	5				85	0	0
" 31	Wheat (1908) ... Dr.	3	21	0	0			
	To Wheat (1907) (seed) ...	2				21	0	0
" 31	Sundry Accounts, viz.:— Dr.							
	Potatoes (1907) ...	10	10	0	0			
	" (1908) ...	11	25	0	0			
	Mangels ...	12	10	0	0			
	Turnips (1907) ...	7	56	0	0			
	" (1908) ...	8	15	0	0			
	Wheat (1907) ...	2	15	0	0			
	" (1908) ...	3	50	0	0			
	Oats ...	4	45	0	0			
	Clover (1907) ...	5	9	0	0			
	Carrots ...	9	5	0	0			
	To Horses ...	17				240	0	0
" 31	Sundry Accounts, viz.:— Dr.							
	Potatoes (1907) ...	10	28	0	0			
	Mangels ...	12	24	0	0			
	Turnips (1907) ...	7	100	0	0			
	Carrots ...	9	15	0	0			
	To Manures ...	13				167	0	0
" 31	Sundry Accounts, viz.:— Dr.							
	Horses ...	17	73	0	0			
	Cattle ...	14	30	0	0			
	Sheep ...	15	67	0	0			
	Pigs ...	16	14	0	0			
	Manures (for manure value) ...	13	61	0	0			
	To Feeding-stuffs ...	18				245	0	0
" 31	Wheat (1908) ... Dr.	3	130	0	0			
	To Sundry Accounts, viz.:—							
	Potatoes (1907) ...	10	......			41	0	0
	Mangels ...	12	......			24	0	0
	Carrots ...	9	......			15	0	0
	Turnips (1907) ...	7	......			50	0	0
" 31	Oats ... Dr.	4	130	0	0			
	To Turnips (1907) ...	7				130	0	0
" 31	Capital ... Dr.	1	222	10	0			
	To Household expenses ...	22				222	10	0
" 31	Rent (Accrued) ... Dr.	25	202	10	0			
	To Landlord ...	32				202	10	0
" 31	Profit and Loss Account ... Dr.	38	952	13	4			
	To Sundry Accounts, viz.:—							
	Turnips ...	7	......			74	0	0
	Mangels ...	12	......			51	0	0
	Manures ...	13	......			120	9	0
	Implements ...	19	......			64	5	0
	General Account ...	20	......			32	16	10
	General Expenses ...	21	......			26	2	6
	Interest ...	24	......			140	10	0
	Rent, Rates, and Taxes ...	25	......			443	10	0
" 31	Sundry Accounts, viz.:— Dr.							
	Wheat ...	2	16	10	0			
	Clover ...	5	41	15	0			
	Carrots ...	9	53	8	0			
	Potatoes ...	10	226	5	0			
	Cattle ...	14	370	15	0			
	Sheep ...	15	438	10	0			
	Pigs ...	16	18	15	0			
	Discount ...	23	1	8	0			
	To Profit and Loss Account ...	38				1167	6	0
" 31	Profit and Loss Account ... Dr.	38	214	12	8			
	To Capital Account for net profit ...	1				214	12	8

LEDGER

1 *Dr.* CAPITAL *Cr.* 1

1908.		Fo.	£ s. d.	£ s. d.	1907.		Fo.	£ s. d.	£ s. d.
Mar. 31	To Household Expenses		222 10 0		April 1	By Sundries as per Balance Sheet		2810 0 0	
" 31	" Balance Capital		2942 12 8						
				3165 2 8	1908. Mar. 31	" Interest.........		140 10 0	
					" 31	" Profit and Loss a/c, Net Profit for year ...		214 12 8	
									3165 2 8
				3165 2 8					3165 2 8
					April 1	" Capital b/d ...			2942 12 8

2 *Dr.* WHEAT (1907) *Cr.* 2

1907.		Fo.	£ s. d.	£ s. d.	1908.		Fo.	£ s. d.	£ s. d.
April 1	To Capital		140 0 0		Mar. 31	By Sales		540 10 0	
" 1	" Capital		440 0 0		" 31	" Wheat (1908)		21 0 0	
1908. Mar. 31	" Wages		50 0 0		" 31	" Stock in hand c/d		100 0 0	
" 31	" Horses		15 0 0						661 10 0
" 31	" Profit and Loss		16 10 0						
				661 10 0					
				661 10 0					661 10 0
April 1	" Stock b/d			100 0 0					

3 *Dr.* WHEAT (1908) *Cr.* 3

1908.		Fo.	£ s. d.	£ s. d.	1908.		Fo.	£ s. d.	£ s. d.
Mar. 31	To Wages		25 0 0		Mar. 31	By Balance c/d ...			226 0 0
" 31	" Wheat (1907)		21 0 0						
" 31	" Horses		50 0 0						
" 31	" Sundry Crop Accounts ...		130 0 0						
				226 0 0					
				226 0 0					226 0 0
April 1	" Balance b/d ...			226 0 0					

4 *Dr.* OATS (1908) *Cr.* 4

1908.		Fo.	£ s. d.	£ s. d.	1908.		Fo.	£ s. d.	£ s. d.
Mar. 31	To Purchases		28 2 6		Mar. 31	By Balance c/d ...			203 2 6
" 31	" Horses		45 0 0						
" 31	" Turnips (1907)		130 0 0						
				203 2 6					
				203 2 6					203 2 6
April 1	" Balance b/d ...			203 2 6					

5 *Dr.* CLOVER (1907) *Cr.* 5

1907.		Fo.	£ s. d.	£ s. d.	1908.		Fo.	£ s. d.	£ s. d.
April 1	To Capital		25 5 0		Mar. 31	By Sales		16 0 0	
					" 31	" Horses		85 0 0	
1908. Mar. 31	" Wages		25 0 0						101 0 0
" 31	" Horses		9 0 0						
" 31	" Profit and Loss		41 15 0						
				101 0 0					
				101 0 0					101 0 0

6 *Dr.* CLOVER (1908) *Cr.* 6

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Purchases......			28 0 0	Mar. 31	By Balance c/d ...			28 0 0
April 1	" Balance b/d ...			28 0 0					

7 *Dr.* TURNIPS (1907) *Cr.* 7

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		8 0 0		Mar. 31	By Wheat (1908)		50 0 0	
1908.					" 31	" Oats		130 0 0	
Mar. 31	" Wages		90 0 0		" 31	" Profit and Loss		74 0 0	
" 31	" Horses		56 0 0						254 0 0
" 31	" Manures		100 0 0						
				254 0 0					
				254 0 0					254 0 0

8 *Dr.* TURNIPS (1908) *Cr.* 8

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Horses			15 0 0	Mar. 31	By Balance c/d ...			15 0 0
April 1	" Balance b/d ..			15 0 0					

9 *Dr.* CARROTS *Cr.* 9

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		11 12 0		Mar. 31	By Sales		80 0 0	
1908.					" 31	" Wheat (1908)		15 0 0	
Mar. 31	" Wages		10 0 0						95 0 0
" 31	" Horses		5 0 0						
" 31	" Manures		15 0 0						
" 31	" Profit and Loss		53 8 0						
				95 0 0					
				95 0 0					95 0 0

10 *Dr.* POTATOES (1907) *Cr.* 10

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		42 0 0		Mar. 31	By Sales		320 0 0	
1908.					" 31	" Wheat (1908)		41 0 0	
Mar. 31	" Purchases......		4 15 0						361 0 0
" 31	" Wages		50 0 0						
" 31	" Horses		10 0 0						
" 31	" Manures		28 0 0						
" 31	" Profit and Loss		226 5 0						
				361 0 0					
				361 0 0					361 0 0

11 *Dr.* POTATOES (1908) *Cr.* 11

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Horses			25 0 0	Mar. 31	By Balance c/d ...			25 0 0
April 1	" Balance b/d ...			25 0 0					

12 *Dr.* MANGELS *Cr.* 12

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		14 0 0		Mar. 31	By Wheat (1908).		24 0 0	
1908.					" 31	" Profitand Loss		51 0 0	
Mar. 31	" Wages		27 0 0						75 0 0
" 31	" Horses		10 0 0						
" 31	" Manures		24 0 0						
				75 0 0					
				75 0 0					75 0 0

13 *Dr.* MANURES *Cr.* 13

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		136 9 0		Mar. 31	By Sundry Crop Accounts......		167 0 0	
1908.									
Mar. 31	" Purchases......		205 0 0		" 31	" Unexhausted Value of Feeding-stuffs c/d		115 0 0	
" 31	" Feeding-stuffs		61 0 0	402 9 0	" 31	" Profit and Loss		120 9 0	402 9 0
				402 9 0					402 9 0
April 1	" Balance b/d ...			115 0 0					

14 *Dr.* CATTLE *Cr.* 14

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		89 18 6		Mar. 31	By Sales		472 0 0	
" 20	" Cash		74 7 6		" 31	" Stock in hand c/d		520 0 0	
" 20	" "		21 10 0						992 0 0
" 20	" "		1 2 6						
" 20	" "		0 16 6						
Dec. 18	" "		3 10 0						
1908.									
Mar. 31	" Purchases......		350 0 0						
" 31	" Wages		50 0 0						
" 31	" Feeding-stuffs		30 0 0						
" 31	" Profit and Loss		370 15 0						
				992 0 0					
				992 0 0					992 0 0
April 1	" Balance b/d ...			520 0 0					

15 *Dr.* SHEEP *Cr.* 15

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		179 10 0		Mar. 31	By Sales		1210 0 0	
1908.					" 31	" Stock in hand c/d		320 0 0	
Mar. 31	" Purchases......		770 0 0						1530 0 0
" 31	" Wages		75 0 0						
" 31	" Feeding-stuffs		67 0 0						
" 31	" Profit and Loss		438 10 0						
				1530 0 0					
				1530 0 0					1530 0 0
April 1	Balance b/d			320 0 0					

16 *Dr.* PIGS *Cr.* **16**

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		102 5 0		Mar. 31	By Sales		109 0 0	
1908.					" 31	" Stock in hand c/d		51 0 0	160 0 0
Mar. 31	" Wages		25 0 0						
" 31	" Feeding-stuffs		14 0 0						
" 31	" Profit and Loss		18 15 0	160 0 0					
				160 0 0					160 0 0
April 1	" Balance b/d			51 0 0					

17 *Dr.* HORSES *Cr.* **17**

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		221 10 0		Mar. 31	By Sundry Crop a/c		240 0 0	
" 17	" Cash		0 5 0		" 31	" Stock in hand c/d		164 15 0	404 15 0
1908.									
Mar. 31	" Purchases		25 0 0						
" 31	" Feeding-stuffs		73 0 0						
" 31	" Clover (1907)		85 0 0	404 15 0					
				404 15 0					404 15 0
April 1	" Balance b/d			164 15 0					

18 *Dr.* FEEDING-STUFFS *Cr.* **18**

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Purchases			245 0 0	Mar. 31	By Sundry a/c			245 0 0

19 *Dr.* IMPLEMENTS *Cr.* **19**

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		284 5 0		Mar. 31	By Stock in hand c/d		226 0 0	
1908.					" 31	" Profit and Loss		64 5 0	290 5 0
Jan. 6	" Cash		6 0 0	290 5 0					
				290 5 0					290 5 0
April 1	" Balance b/d			226 0 0					

20 *Dr.* GENERAL ACCOUNT *Cr.* **20**

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 1	To Capital		24 1 10		Mar. 31	By Profit and Loss		32 16 10	
1908.					" 31	" Stock in hand c/d		28 0 0	60 16 10
Mar. 31	" Wages		36 15 0	60 16 10					
				60 16 10					60 16 10
April 1	" Balance b/d			28 0 0					

21 *Dr.* GENERAL EXPENSES *Cr.* 21

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 3	To Cash		0 2 6		Mar. 31	By Profit and Loss			26 2 6
1908.									
Mar. 31	" "		26 0 0						
				26 2 6					
				26 2 6					26 2 6

22 *Dr.* HOUSEHOLD AND PERSONAL EXPENSES *Cr.* 22

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
April 30	To Cash		12 10 0		Mar. 31	By Capital			222 10 0
1908.									
Mar. 31	" "		210 0 0						
				222 10 0					
				222 10 0					222 10 0

23 *Dr.* DISCOUNT *Cr.* 23

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1907.				
Mar. 31	To Profit and Loss			1 8 0	June 1	By Sutton & Co.			1 8 0

24 *Dr.* INTEREST *Cr.* 24

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Capital			140 10 0	Mar. 31	By Profit and Loss			140 10 0

25 *Dr.* RENT, RATES, TAXES, AND INSURANCE *Cr.* 25

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
Nov. 1	To Cash		202 10 0		Mar. 31	By Profit and Loss			443 10 0
1908.									
Jan. 9	" "		3 10 0						
Mar. 31	" "		35 0 0						
" 31	" Landlord		202 10 0						
				443 10 0					
				443 10 0					443 10 0

26 *Dr.* J. CRESSWELL *Cr.* 26

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
Nov. 29	To Hay		16 0 0		Jan. 20	By Cash		61 0 0	
1908.					Mar. 31	" Balance c/d ...		60 0 0	
Jan. 20	" Pigs		45 0 0						121 0 0
" 29	" Sheep............		60 0 0						
				121 0 0					
				121 0 0					121 0 0
April 1	" Balance b/d ...			60 0 0					

27 *Dr.* J. Smith *Cr.* 27

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1907.				
Mar. 31	To Balance c/d ...			70 0 0	Oct. 24	By Sheep			70 0 0
					1908.				
					April 1	" Balance b/d ...			70 0 0

28 *Dr.* J. Nash *Cr.* 28

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1908.				
May 18	To Sheep............		130 0 0		Mar. 31	By Balance c/d ...			252 0 0
Dec. 18	" Cattle		122 0 0						
				252 0 0					
				252 0 0					252 0 0
1908.									
April 1	" Balance b/d ...			252 0 0					

29 *Dr.* Greenwood & Co. *Cr.* 29

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1907.				
Nov. 4	To Wheat		472 10 0		Nov. 29	By Cash		472 10 0	
1908.					1908				
Jan. 20	" "		68 0 0		Jan. 27	" "		68 0 0	
				540 10 0					540 10 0
				540 10 0					540 10 0

30 *Dr.* A. Brown *Cr.* 30

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1907.				
Nov. 12	To Potatoes		240 0 0		Dec. 7	By Cash		240 0 0	
1908.					1908.				
Jan. 27	" "		80 0 0		Mar. 31	" Balance c/d ...		80 0 0	
				320 0 0					320 0 0
				320 0 0					320 0 0
April 1	" Balance b/d ...			80 0 0					

31 *Dr.* J. Corner *Cr.* 31

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1907.				
Dec. 18	To Carrots			80 0 0	Dec. 26	By Cash			80 0 0

32 *Dr.* Landlord *Cr.* 32

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908.					1908.				
Mar. 31	To Balance.........			202 10 0	Mar. 31	By Rent			202 10 0
					" 31	" Balance b/d ..			202 10 0

33 *Dr.* J. Morris & Co. *Cr.* 33

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907.					1907.				
May 2	To Cash		15 0 0		April 3	By Manures		15 0 0	
Dec. 15	" "		25 0 0		Nov. 29	" Feeding-stuffs		9 0 0	
				40 0 0	Dec. 7	" "		16 0 0	
									40 0 0
				40 0 0					40 0 0

34 *Dr.* SUTTON & CO. *Cr.* 34

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907. June 1	To Cash		26 12 0		1907. April 14	By Seeds............			28 0 0
" 1	" Discount		1 8 0	28 0 0					
				28 0 0					28 0 0

35 *Dr.* GRIFFIN & CO. *Cr.* 35

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907. June 15	To Cash		15 0 0		1907. April 16	By Manures		30 0 0	
1908. Mar. 31	" Balance c/d ...		35 0 0		Nov. 29	" "		20 0 0	50 0 0
				50 0 0					
				50 0 0					50 0 0
					1908. April 1	" Balance b/d...			35 0 0

36 *Dr.* J. CULLIMORE *Cr.* 36

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907. April 11	To Cash			4 15 0	1907. April 3	By Potatoes			4 15 0

37 *Dr.* C. EVANS *Cr.* 37

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1907. April 20	To Pigs			30 0 0	1907. April 23	By Cash			30 0 0

38 *Dr.* PROFIT AND LOSS ACCOUNT *Cr.* 38

		Fo.	£ s. d.	£ s. d.			Fo.	£ s. d.	£ s. d.
1908. Mar. 31	To Turnips.........		74 0 0		1908. Mar. 31	By Wheat		16 10 0	
" 31	" Mangels........		51 0 0		" 31	" Clover		41 15 0	
" 31	" Manures		120 9 0		" 31	" Carrots.........		53 8 0	
" 31	" Implements ...		64 5 0		" 31	" Potatoes		226 5 0	
" 31	" General Account		32 16 10		" 31	" Cattle		370 15 0	
" 31	" General Expenses.........		26 2 6		" 31	" Sheep		438 10 0	
" 31	" Interest...... ...		140 10 0		" 31	" Pigs		18 15 0	
" 31	" Rent, rates, taxes, and insurance ...		443 10 0		" 31	" Discount		1 8 0	
				952 13 4					1167 6 0
" 31	" Balance (profit transferred to Capital)			214 12 8					
				1167 6 0					1167 6 0

BALANCE SHEET, AS AT MARCH 31st, 1908

LIABILITIES.	£	s.	d.	£	s.	d.
Debts payable:—						
J. Smith	70	0	0			
Griffin & Co.	35	0	0			
Landlord	202	10	0			
				307	10	0
Capital				2942	12	8
				3250	2	8

ASSETS.	£	s.	d.	£	s.	d.
Debts receivable:—						
J. Cresswell	60	0	0			
J. Nash	252	0	0			
A. Brown	80	0	0			
				392	0	0
Wheat—						
Unthrashed grain				100	0	0
Cultivations and manures for benefit of this crop ...				226	0	0
Oats—						
Cultivations and manures for benefit of this crop ...				203	2	6
Clover—						
Seeds sown				28	0	0
Turnips—						
Cultivations, ploughing and harrowing				15	0	0
Potatoes—						
Cultivations, ploughing and harrowing				25	0	0
Manures—						
Unexhausted value of feeding-stuffs				115	0	0
General account—straw ...	25	0	0			
" shrubs ...	3	0	0			
				28	0	0
Cattle—						
4 cows	60	0	0			
30 two-year-old steers ...	440	0	0			
Implements and utensils ...	20	0	0			
				520	0	0
Sheep—						
180 wethers	310	0	0			
Utensils and implements ...	10	0	0			
				320	0	0
Pigs—						
3 breeding sows	12	0	0			
Boar	6	0	0			
18 porkers	25	0	0			
Utensils	8	0	0			
				51	0	0
Horses—						
Riding horse, with saddle and bridle	20	15	0			
No. 1 pair—Tom and Bob	45	0	0			
No. 2 pair—Captain and Daisy	40	0	0			
No. 3 pair—Stirling and Smart	30	0	0			
No. 4 pair—Music and Colonel	29	0	0			
				164	15	0
Implements as per Inventory				226	0	0
Cash in bank	638	11	8			
Cash in hand	197	13	6			
				836	5	2
				3250	2	8

The foregoing examples of how the various books are kept will, it is hoped, be found sufficient to enable anyone, though previously unacquainted with the art of bookkeeping, to commence.

We have now to describe the closing of the accounts at the end of the year, and the preparation of the Profit and Loss Account, and the Balance Sheet.

An Inventory of the live and dead stock, crops, cultivations, and all the farmer's assets on or in the farm is prepared. The Cash Book and Day Books are entered up to date, and the items in these books are posted in the Ledger. Balancing the accounts consists of entering the values of any stock, cultivations, &c., shown in the Inventory on the Creditor side of the accounts to which they belong, and inserting the difference of the totals of the two sides on the lighter one so as to *balance* them. Capital Account is left until all the others are closed and the Profit and Loss Account is prepared, for it has to receive the balance of the latter account.

The Profit and Loss Account is prepared by carrying to it the balances of the various trading and expenses accounts. The former have on the Debtor side the value of stock at the commencement of the year, and of purchases during the year, together with expenses incurred. On the Creditor side they have the value of sales during the year, and of stock in hand. The balance or difference between the two sides is therefore profit or loss. No difficulty can arise in regard to the expenses accounts, their balances are plainly losses. Losses are transferred to the Debtor and profits to the Creditor side.

After all accounts have been adjusted and the net profit or loss ascertained for the year, the Profit and Loss Account is closed by a transfer of the balance to the Capital Account. If the year's farming has resulted in a profit, the credit side of the Profit and Loss Account will be the greater, in which case the balance will be a transfer to the credit side of the Capital Account, thereby increasing the farmer's Capital by the amount of the net profit. If the year's working has resulted in a loss, the entry from the Profit and Loss Account will be transferred to the debit side of the Capital Account, and the farmer's Capital will be decreased by the amount of the net loss.

When a Private Expenses Account is opened for the farmer's private drawings, in addition to the Capital Account, this Private Account will be closed by a transfer to the debit of the Capital Account at the close of the financial year.

The Capital Account is next closed; its balance shows the amount of capital invested in the farm at the date of closing. A Profit and Loss Account prepared in the manner just described gives a correct statement of the profits derived from each single crop or class of live stock. Such information is very useful to the farmer, as it enables him to see which crop or which class of live stock has been most profitable to him. To get this information it is necessary to distribute the cost of feeding-stuffs among the different classes of live stock, of manures to the various crops, and of the disposal of the crops to the live stock. These entries are first arranged in the Journal as here shown in the case of Horses, Feeding-stuffs, and Manures Accounts, and are then posted to the Ledger Accounts before the values of stock in hand.

When the Balance Sheet has been drawn out, the difference between the Assets and Liabilities will represent the farmer's Capital, and this amount should agree with the balance shown in the Capital Account in the ledger.

We must give an explanation of one other account which usually appears in a farmer's books — that which is denominated the Unexhausted Improvements Account. More than one of these accounts may be opened, each being named after the year in which it is to expire. In the case above, improvements supposed to last till the end of the lease, which has fifteen years to run, might have their expenses entered in a 1922 Unexhausted Improvements Account; but for other expenses, whose returns will not last so long, other accounts might be opened, naming them according to the date at which the benefit of the outlay in each may be expected to have disappeared. And of course, the valuation, at the end of each successive year, of the improvements specified in these accounts will diminish with the lapse of time — they will diminish as the period approaches when it is assumed that they will altogether expire. Every year, then, a portion, dependent upon the period which the account has yet to run — $\frac{1}{15}$, as in the above case, $\frac{1}{9}$, $\frac{1}{4}$, $\frac{1}{2}$, or *all* (according as that period has 15, 9, 4, *or 2 years to run, or has just terminated), must be* deducted from the whole amount on the Dr. side of the account, and credit taken for the remainder only in the inventory of tenant's property at the close of the year.

Bills of Exchange play an important part in business at the present day, and sometimes enter into a farmer's business transactions. They may be entered in the Journal, the entries being for a Bill Payable, drawn, say, by James Williams—James Williams Dr. to Bill Payable, and for a Bill Receivable accepted by Williams —Bill Receivable Dr. to Williams.

We must add one word more. Farm accounts may be made as simple as is desired. If it be so desired, only five accounts might be opened in the ledger, and three only of these need appear in the balance sheet. 'Grain crops' might receive all payments and receipts on account of wheat, oats, barley, beans, &c. 'Green crops' might receive all payments and receipts connected with the growth and *consumption* of turnips, clover, &c.: thus it would receive accounts of manure and live stock. 'Horses' and 'Rent and Taxes' would receive each its own special class of expenses, to be divided afterwards between the corn and green crop accounts. And unexhausted improvements would, as we have already explained, receive the account of those expenses the returns from which are expected to be spread over several years.

It will be found very useful to have a separate memorandum book for the stack yard, stating the field whence each stack came, the date it was thrashed, the quantity it contained, &c. Stock books would likewise be useful, and might be entrusted to those labourers having charge of each class of them. As the information thus afforded, however, does not affect the balance sheet, we do not dwell on the best form for these books, or the manner in which they should be kept; the farmer himself will easily arrange this.

Surely the above statement will enable anyone, from this time, to commence a system of farm accounts which shall always keep before him his own position in money matters; greatly increase his stock of information in the details of his profession; and, at the same time, encourage a spirit of definite and particular observation, which will contribute much to professional improvement. In addition to persuasion, we conclude by way of warning, in the words of a late Attorney-General—'Bad bookkeeping is certainly the high road to bankruptcy'.

[J. O. P.]

Acer, the botanic name of the genus of trees to which the maple belongs. See MAPLE.

Acetylene is a gaseous compound of hydrogen and carbon represented by the formula C^2H^2. It is colourless, and has a rather pleasant ethereal odour when pure, but as ordinarily prepared it is apt to contain small quantities of sulphuretted hydrogen and phosphoretted hydrogen, which impart to it a strong, disagreeable smell. It is present in small quantities in ordinary coal-gas. Acetylene burns readily, its ignition temperature being a little under that of coal-gas. If there is not a sufficient supply of air, the flame is dull and very smoky, but when a proper burner is used, in which a very thin or flat jet of gas can burn with abundant access of air, acetylene gives a very white and brilliant flame, with an illuminating power of 240 candles. It is thus about fifteen times as rich in light-giving power as ordinary coal-gas. In recent times acetylene has come into extensive use as an illuminant, chiefly on account of the cheapness with which it can now be prepared from calcium carbide, a substance manufactured by subjecting a mixture of coke and lime to the heat of an electric furnace. When this substance is brought into contact with water, acetylene is given off according to the chemical equation,

$$CaC^2 + 2\,H^2O = Ca(OH)^2 + C^2H^2;$$

slaked lime, $Ca(OH)^2$, being the other product of the reaction. To provide a supply of acetylene gas for lighting purposes, various forms of generator are in use, and in these the carbide may either be brought slowly into contact with the water, or the water may be brought gradually into contact with the carbide, or the two may be brought together at intervals and then separated.

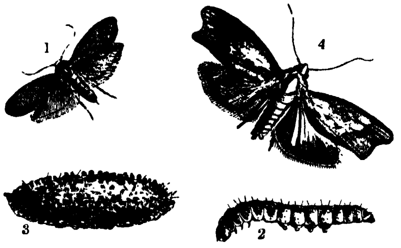
A complete plant for supplying say twelve lights, burning at the same time, costs from £12 to £30 according to the system used. A fair estimate of the cost of service pipes, stopcocks, brackets, pendants, &c., would be about 30*s.* per light. Calcium carbide is now so much cheapened that acetylene can be produced at a price which compares favourably with coal-gas and petroleum. It is important that all pipes and fittings should be perfectly sound, as acetylene when inhaled even in small quantities is very injurious. Acetylene hand-lamps are now placed on the market, which not only give a superior light and smell less, but are in fact cleaner and safer than ordinary petroleum lamps, the carbide being less liable than petroleum to run when accidentally upset.

Acherontia atropos (Death's-head Moth; Bee Tiger-moth).—This beautiful moth is the parent of one of the largest caterpillars found in Europe. It feeds upon the flowers and leaves of the potato, and occasionally injures the crop; the food it consumes is very considerable; and sometimes these larvæ abound to such an extent that they have been collected and given to poultry. It also feeds upon Jessamine. The caterpillar is often as large and thick as a man's finger, of a greenish-yellow colour, with oblique stripes of purple, blue, and white down each side; the back is terminated by a rough curved tail; it has sixteen feet. Some are full-grown in July, others in October, when they descend into the earth to form cells, and change to shining pupæ of a deep mahogany colour. The moth hatches in September or October. Sometimes they remain two years in the pupal stage. The upper wings are black freckled with white, and variegated with rust colour; upon the thorax is roughly portrayed the figure of a human skull and clavicles: the under wings are deep-yellow, with a double black border. The body is banded with yellow and black, but grey down the centre; the two antennæ are black, white at the tips. It has six stout legs, also a short proboscis; and it can squeak like a mouse. [J. C.]

Achillea, a genus of plants of the nat. ord. Compositæ to which belongs Yarrow or Milfoil. See YARROW.

Achorutes armatus (the Bean Springtail).—These small springtails (Aptera) are recorded as gnawing the roots of kidney and other beans in Ireland. They belong to the so-called Collembola, and are probably more important as plant destroyers than we are at present aware. [F. V. T.]

Achroia grisella (the Wax-moth) is one of the worst enemies the bee-keeper has to encounter if his hives are not carefully looked after. The moths are very active, getting into the hives, where they deposit their eggs, and when they hatch, the maggots feed upon the wax, which is not all, for they spin webs wherever they dwell, covered with their skins and excrement, rendering the comb so offensive that the bees forsake the hive. The moth is like satin, of a pale-yellowish ash-colour; head ochreous, with shining depressed scales; thorax and upper wings mouse colour, fig. 3, (1, the female). It appears in June and July. Weak stocks are mostly affected; where the hives are properly attended, and any trace of the webbing and larvæ at once removed, no trouble is likely to be found from this insect. [J. C.]

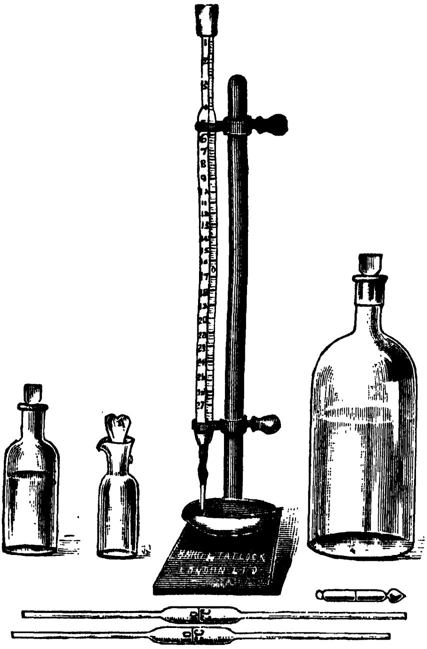


1, *Achroia grisella*, female; 2, larva; 3, pupa; 4, male adult

Acidia heraclei (the Celery Fly) is a beautiful fly which lays its eggs on the upper side of the leaves of parsnips and celery. The larvæ mine and blister the leaves, which turn brown and shrivel up. Much harm is thus done by stunting the growth of the celery, and parsnips become forked and deformed. The fly appears in April. Its wings have dark-brown marks running across them; the body honey-yellow; legs dark-yellow; length, ⅛ in.; wing expanse nearly ½ in. The eggs are laid singly and hatch in 6 days, and the larvæ at once tunnel into the tissue. They are footless, white to pale-green, and may easily be seen feeding between the upper and lower skins of the leaves. They mature in 14 to 16 days, and then change to a yellowish puparium either in the leafage or under the soil. The puparium is ⅛ to ⅐ in. long. In a few days the fly hatches out in summer. Several broods occur. Winter is passed in the soil and dead leaves in the puparium stage.

Prevention and treatment consists in spraying the young plants now and then with weak paraffin emulsion; in forcing the plants on with nitrate of soda and salt, and frequent waterings. Infested leaves should be destroyed, and the ground deeply trenched in winter so as to bury the yellow puparia. [F. V. T.]

Acidimeter.—A term for an instrument by which the acidity of milk can be measured. For the purpose of the test, the acidity of milk is considered to be neutralized when it gives a faint pink colour to phenolphthalein. The acidimeter consists of a burette—a long graduated tube with a tap or pinch-cock at the bottom—from which the alkaline solution used to neutralize the acidity is run, a stand, a pipette to measure the milk, a porcelain dish, and a glass stirring-rod; an alkaline solution (usually $\frac{1}{10}$ normal caustic soda) and a 0·5-per-cent solution of phenolphthalein are used for the test—the last serving as an 'indicator'.



M'Creath's Dairy Acidimeter

The test is performed by measuring 10 cubic centimetres of milk into the basin, adding several drops of phenolphthalein solution, and running in the alkaline solution while constantly stirring the milk till the milk is faintly pink. The quantity of alkaline solution used as shown by the divisions on the burette gives the acidity in degrees, *i.e.* number of cubic centimetres of $\frac{1}{10}$ normal caustic soda per 100 c.c. of milk, or by multiplying by 0·009 as percentages of lactic acid. In Germany Soxhlet-Henkel degrees are used, which equal four times an English degree. Fresh milk has an acidity of about 20°, and when the acidity reaches 33° it curdles on boiling. The acidimeter is used to test milk for freshness, cream to ascertain whether it is ripe for churning, and milk and whey while cheese-making. [H. D. R.]

Acids.—Acids belong to a definite class of chemical compounds. Their existence in nature has been known from very early times, but it is only within the last century that their occurrence, importance, chemical composition, and characters have been well defined.

They are sour or sharp to the taste, and have the power of turning red the blue vegetable colouring matter litmus. Their most important and characteristic property is, however, the fact that they all contain the element hydrogen associated with some other element or group of elements. When added to a base (see BASE), the element hydrogen is substituted for the base and a substance possessing neutral properties is formed, namely, a salt (see SALTS). The hydrogen is given off either in the free state or in combination with oxygen to form water. Some of the more common elements found in combination with hydrogen-producing acids are: oxygen, nitrogen, chlorine, sulphur, phosphorus, silicon, and carbon.

Salts are less chemically active than acids, and it is in the former chemical state rather than in the free state that acids are more generally found to occur in nature. The corrosive action of acids is well known; some have greater power in this respect than others, also some acids are said to be stronger than others. A strong acid can replace a weak acid from its combination with bases, and the salts of the former are more stable than those of the latter. When vinegar, which is a dilute solution of acetic acid, is added to chalk, the carbonic acid which is in combination with the lime in chalk, being a weaker acid and having less affinity or attraction for the lime, is replaced by the acetic acid, and a salt of acetic acid with lime is formed. In this way decompositions or interchanges of acids in salts are of continual occurrence in vegetable and animal life. In soils where the plant food is stored up in the form of stable and insoluble salts, such salts only become available or of access to growing plants by such processes. In the digestive changes that food undergoes in the alimentary canal, similar chemical changes are found to be in progress. The manufacture of some artificial manures, such as superphosphate of lime by the action of sulphuric acid upon tricalcium-phosphate, is another instance. Innumerable examples could be stated, but those mentioned are sufficient for our purpose here.

Acids are grouped into two great classes—those of so-called mineral origin, termed inorganic acids, and those of vegetable or animal origin, termed organic acids. (See ACIDS IN PLANTS.) The principal inorganic acids connected in any way with the practice of farming are nitric, phosphoric, carbonic, sulphuric, hydrochloric, silicic, and arsenic. Their use in agriculture as free acids is of a limited nature; but it is in combination with bases or salts that their importance lies. In this state they form the food for plants, and largely provide the material of which our soils are made. For the preparation, chemical characteristics, and other properties of these acids, the reader is referred to a text-book on inorganic chemistry. The following table supplies a few important facts concerning them:—

Name of Acid.	Chemical Formula.[1]	Name of Salt.
Hydrochloric or Muriatic	HCl	Chloride or Muriate
Nitric	HNO^3	Nitrate
Phosphoric	H^3PO^4	Phosphate
Carbonic	H^2CO^3	Carbonate
Sulphuric	H^2SO^4	Sulphate
Silicic	H^2SiO^3	Silicate
Arsenic	H^3AsO^4	Arsenate

[R. A. B.]

Acids in Plants.—Many plants at certain stages of their growth contain appreciable quantities of free acids. Owing to their occurrence in plant tissues and juices they are generally called vegetable acids, though they are not confined to the plant kingdom, for they exist abundantly as salts in some parts of the animal body, animal fat being a mixture of salts of these acids.

Besides their occurrence in living plants and animals, they are often produced as one of the products in the fermentation and decay of vegetable and animal substances, hence their occurrence in some soils. These vegetable acids belong to an important class of acids called Organic. Carbon is one of their essential constituents, the others being oxygen and hydrogen, and sometimes nitrogen. They are acid to the taste, and combine with bases, forming salts. Originally it was thought by chemists that they could only be prepared through vital processes such as those associated with vegetable and animal life; but as investigation into their properties and relationships with other chemical compounds proceeded, methods were devised for their manufacture by artificial processes. It is now possible to prepare a large number of them by such means.

Almost all the natural orders of plants have been found to contain organic acids, some being peculiar to certain orders. The free acids are generally found in the young growing plant, principally in the immature fruit, and to a much smaller extent in the sap. They are, however, more generally found in combination with bases or salts, in which state they are very widely distributed throughout the vegetable world. It is estimated by Dr. Bernard Dyer that the juice secreted by the roots of plants has an acidity equal to about 1 per cent of citric acid. He found that the amount varied considerably with different families of plants, but taking the average of a large number of plants from different orders the acidity amounted to the above figure. This property was made the basis of a method for determining the available plant food in soils.

Some of the common acids found in plants are malic, oxalic, citric, acetic, tartaric, and lactic. It is stated that during the ripening processes in some fruits, a transformation of one acid into another goes on. The unripe berries of mountain ash contain tartaric acid, which as the fruit matures is converted into malic acid. This same chemical change can be brought about by artificial methods. From their temporary nature in plants, free acids must be regarded more as intermediate substances, derived either from the oxidation of carbohydrates, or as products resulting from the metabolic changes incident to the life of plants. Undoubtedly they play an important part as providing a means of removing from the sap of plants excessive and useless amounts of mineral substances, which appear as salts either deposited in crystalline masses in some of the older tissues, or as incrustations on the epidermis of the stem and leaves. They may aid also in the transference of material in the sap from one part of the

Name of Acid.	Chemical Formula.[1]	Occurrence.
Malic	$C^4H^6O^5$	Unripe apples, grapes, barberries, quince, plums, cherries, strawberries, &c.
Citric	$C^6H^8O^7$	Lemons, oranges, red bilberries, currants, cherries, beet-root, vetches, pea seeds.
Tartaric	$C^4H^6O^6$	Mountain-ash berries, pine-apple, potato, and many other fruits; product from fermentation of grape juice.
Oxalic	$C^2H^2O^4$	Wood sorrel, principally as salts in many other plants.
Acetic	$C^2H^4O^2$	Juices of various plants and trees, vinegar.
Formic	CH^2O^2	Pine needles, nettles.
Oleic	$C^{18}H^{34}O^2$	Constituent of olive and almond oil.
Propionic	$C^3H^6O^2$	Yarrow flowers.
Butyric	$C^4H^8O^2$	Parsnip seeds, as oil in seed of giant cow parsnip.
Valeric	$C^5H^{10}O^2$	Valerian root.
Caproic	$C^6H^{12}O^2$	Cocoa-nut oil.
Pelargonic	$C^9H^{18}O^2$	Geranium.
Capric	$C^{10}H^{20}O^2$	Cocoa-nut.
Lauric	$C^{13}H^{24}O^2$	Laurel oil.
Aconitic	$C^6H^6O^6$	Common aconite (monkshood), hair-grass, sugar-cane.
Benzoic	$C^7H^6O^2$	Gum benzoin, cranberries, castoreum, &c.
Umbellic	$C^{11}H^{22}O^2$	Seeds of California laurel.
Myristic	$C^{14}H^{28}O^2$	Nutmeg oil.
Isocitic	$C^{15}H^{29}O^2$	Seeds of Jatropha.
Palmitic	$C^{16}H^{32}O^2$	Palm oil, &c.
Caffeic	$C^9H^8O^4$	Coffee.
Quinic	$C^7H^{12}O^6$	Quinine bark, coffee beans, &c.
Arachic	$C^{20}H^{40}O^2$	Pea-nut oil.
Behenic	$C^{22}H^{44}O^2$	Oil of *Moringa oleifera.*
Gallic	$C^7H^6O^5$	Nutgalls, tea, &c.
Tannic	$C^{14}H^{10}O^9$	Nutgalls, tea, &c.

---

[1] For explanation of formula see article on CHEMISTRY.

[1] For explanation of symbols see CHEMISTRY.

plant to another, by assisting in the solution of such material. As ethereal salts they are stored as oils and fats in the seeds of oil-bearing plants. They are of no practical value as a food-stuff for animals except when they occur as oils and fats; but many of them possess great commercial value for pharmaceutical purposes, and as constituents of beverages, and in combination with glycerine as oils. The table on p. 42 gives the composition and occurrence of many of the vegetable acids [R. A. B.]

Acids in Soil.—Two general classes of soil acids are to be distinguished, organic and inorganic. They differ in origin, and to some extent require different cultural treatment, but their general effect on the plant is the same.

Organic acids arise during the anaërobic decomposition of organic matter, *i.e.* decomposition proceeding in absence of air. They occur in water-logged soils like peat beds and wet black sands. The iron oxide is dissolved by them out of the peat, and washes either into the ditches, where it is precipitated as a red slime by certain organisms (Crenothrix and Cladothrix), or else into the subsoil, where it is liable to produce a pan. Sand or gravel lying under the peat is often bleached by losing its iron oxide in this way. Such acids will also attack metals; hence moorland water dissolves lead from pipes, and can only be used as a town supply after treatment with calcium carbonate. The exact nature of these acids is not known; further details are given under HUMUS.

Inorganic acids may arise from manures. When ammonium sulphate is continuously used on land deficient in lime it is found that the soil becomes acid. Well-known instances are afforded by the continuous wheat and barley plots at Woburn, and some of the Rothamsted grass plots. It appears that the ammonia is taken up by organisms, leaving the acid free. See MANURES, EFFECT OF, ON SOIL.

The effect of the acid is twofold: it profoundly modifies the micro-organic flora of the soil, and it affects plant growth. Certain beneficent types of organisms, *e.g.* nitrifying bacteria, are adversely affected, and tend to be crowded out; other injurious ones, *e.g.* the organism causing finger-and-toe, flourish and multiply. Few cultivated plants can tolerate acid: at Woburn the barley ceases to grow, and its place is taken by sorrel; on the Rothamsted acid grass plots bent grass and sheep's fescue alone survive, other grasses and Leguminosæ fail.

Liming is found to have a very good effect, and phosphates are often beneficial; basic slag is therefore a suitable manure. The cultivation and drainage must be good. [E. J. R.]

Acne.—By this name several skin eruptions upon animals are often implied, but having a general resemblance in the inflammation of the sebaceous follicles and sweat glands, leading to the formation of pimples. The pressure of harness, on the under side of which sweat has been allowed to dry and accumulate, is the most fruitful source of this malady. Under the saddle and other situations occur firm but painful nodules, from which tallow-like plugs may be squeezed, having on their summit a yellowish-brown exudation or dry scab. Prolonged irri-

dlery excites
the skin, and
When these
re, an ulcer,
remains. A
onfused with
distinguished
ody, and not
essure is felt
med to wear
condition at
most bearing.
d peculiar to
l by Canadian
ppearance to
the matter in
character of
thing as well
lely over the
form of short
e bacillus, is

on-infectious
ions, alkaline
bicarbonate
glycerine in
tly, to allay
by iodide of
heroic treat-
acid, applied
pimple, has
re of success.
ould receive
d, nitrate of
d aluminium
with a view
h healing of
[H. L.]

bane). — The

Blue-flowered Monkshood (*Aconitum Napellus*)

common name Monkshood refers to the hood shape of the uppermost sepal of the calyx, and the name Wolfsbane to the excessively poisonous properties of the plants. This genus belongs to the Buttercup family, Ranunculaceæ, and is easily distinguished by its calyx not being green but brightly coloured, blue in some species, and yellow in others. The uppermost sepal of this calyx takes the form of a hood, within which two hammer-shaped petals are contained. The species are robust, free-growing perennials, reaching a height of 2 to 6 feet, and bear terminal racemes of showy flowers. Though often cultivated in Britain, they are not native plants. The roots, or rather rootstocks, are fleshy, persistent, and specially poisonous. They have been used by mistake for horse-radish with fatal result. The ancients, indeed, regarded Aconite as the most virulent of all poisons. In Northern India an arrow poison is extracted from the roots. The species most commonly cultivated in Britain is the Blue-flowered Monkshood (*Aconitum Napellus*), with glossy palmate leaves divided into narrow strips, and dark-brown roots (rootstocks) shaped like a little turnip.

[A. N. M‘A.]

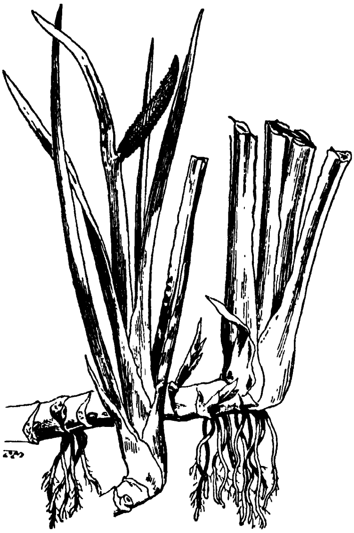
Aconitum. See ACONITE.

Acorns are the fruits of the Oak tree (see OAK). Those of the two oaks indigenous to Britain (*Quercus pedunculata* and *Q. sessiliflora*) ripen in October and November, and germinate during the following spring. Fresh acorns possess a considerable amount of nutritive matter, analysis showing the following average percentages: Water 55·3, nitrogen (free extract) 34·8, fibre 4·4, protein 2·5, fat 1·9, and ash 1·0. The acorns of the Barbary Oak (*Q. Ballota*) are sweet and nutty, and some of those produced in Turkey are, after being buried in the ground, dried, washed, ground, and made into ‘palamonte’ with sugar and spices, from which a very nutritious and fattening dish named ‘racahout’ is prepared. Those produced by our British oaks, however, are only suitable for the feeding of swine, deer, and cattle. In ancient days in England the annual crops of acorns and beech-nuts in the woodlands were of untold value for the pannage of swine, which then formed the chief wealth of the rural population. Their importance may be estimated from the fact that the earliest extant specimen of West Saxon legislation, the laws of King Ine (about 690 A.D.), imposed penalties on the burning of such mast-producing trees, and fixed the value of a tree by the number of swine that could find shelter under it. But the herding of swine in the woods continued to be of immense importance for many centuries after that; and in the Forest Charter of 1225, promulgated in the reign of Henry III, one of the sections was: ‘(9) Who may take Agistment and Pawnage in Forests’—‘agistment’ being the fees for the grazing of cattle, and ‘pawnes’ those for the pannage of swine. The cattle and swine were then, however, only admitted into the royal forests from about midsummer till Michaelmas, so as to interfere neither with the young deer nor with the growth of the flushing coppices. Notwithstanding their nutritive properties, too large a proportion of acorns acts poisonously on young cattle, which devour them eagerly. After warm, dry spring and hot summer weather have produced an unusually large supply of acorns (as in 1893 and 1906), there is therefore usually considerable danger of acorn-poisoning’ among young cattle below two years of age, while milch cows and beasts over three years old seldom suffer thus. So, too, swine fed too largely on or surfeited with acorns are apt to contract a distemper called ‘garget’, although Gloucestershire farmers consider acorns preferable to beans for fattening hogs, increasing their weight, and rendering their bacon firm. They therefore prize their feeding quality very highly. In deer parks, however, these good acorn years are useful in diminishing the necessity for artificial feeding in winter. If acorns are wanted for nursery work, only the good large ones should be collected and sown in autumn. In order to prevent their being eaten by squirrels, mice, pheasants, &c., the best way of protecting them there is to coat them before sowing by damping and rolling them in red-lead powder, or coating them with some other strong-smelling composition objectionable to such rodents and birds. If large quantities have to be stored over winter, they should be kept in a fairly dry and airy place, and be raked over from time to time to prevent their becoming overheated or drying up within the shell. Acorns should be sown about 3 to 4 in. apart in drills 12 to 15 in. apart, and covered with about 1½ to 2 in. of soil, and the seed-beds must be kept free from weeds. One pound contains about 125 seeds of *Q. pedunculata* and 150 of *Q. sessiliflora*, and good seed has a germinative capacity of about 65 per cent. For broadcast sowings in woods, from 8 to 16 bushels, weighing from about 450 to 900 lbs., are required per acre. An old English method of raising oak woods on good land was to dibble in the acorns about 12 in. apart after the land had been ploughed for sowing wheat. And when the wheat crop was hand-reaped in the following summer the young oak plants remained uninjured.

[J. N.]

Acorns. 1, *Quercus pedunculata*; 2, *Quercus sessiliflora*

Acorus Calamus (Sweet Flag).—The Sweet Flag belongs to the Arum family of the Monocotyledons. It is a perennial plant, with a stout creeping rhizome, inhabiting the banks of rivers and low marshy ground. It is very rare in Scotland, but quite common in the fens of England, where it grows associated with the Yellow Flag or Iris. It has narrow leaves about 3 ft. long, resembling in form the blade of a straight sword, and springing directly from the creeping rhizome. The flowering stem is two-edged like a leaf, and ends in a narrow green cone of compacted flowers (spadix). The cone spadix is pushed to one side by the spathe leaf (6 in. long), which thus appears to form a continuation of the flower-bearing stem. The whole plant is aromatic, and when bruised emits a pleasant fragrance, whence it was formerly employed among rushes for strewing the floors of rooms. Its sweet-smelling rhizome, called 'Calamus root', is employed in the preparation of hair powder and other perfumery, for flavouring herb-beers, gin, and snuff, for chewing to clear the voice, and is a useful medicine in ague when tonics are required. It should be taken up in the autumn, before the marshes are overflowed, and dried in the shade for use. Sweet Flag forms a part of the coarse hay of marshy land, but it has not been found to possess any particular virtue as food, and must be regarded as a weed rather than as a plant for cultivation. It disappears as soon as its place of growth is drained and tilled, abundance of water being necessary to its existence. Before flowering, it is easily distinguished from Iris by the absence of wax-powder on its leaves, and by the presence of fragrant aroma. [J. L.] [A. N. M'A.]



Sweet Flag (*Acorus Calamus*)

Acquiescence. See Rei Interventus

Acre (see also Weights and Measures).—This term, when its etymology is traced, originally signified open country, untenanted land, forest land, but with the advance of the agricultural state it became gradually narrowed down to its present signification. The oldest meaning of the word in English was tilled land, then an enclosed and defined piece of land, a piece of land of definite size, a land measure. The old meaning is now obsolete except in place names such as Longacre, Broadacres. Longfellow also gives an example of its general application in his lines: 'I like that ancient Saxon phrase, that calls the burial place God's Acre'.

As a measure of land more or less definite, it was first taken to be as much as a yoke of oxen could plough in a day, and then by various statutes, 5 Ed. I, 31 Ed. III, 24 Hen. VIII, to a piece 40 poles long by 4 broad, or its equivalent of any shape. Subsequently by the Act 6 George IV, chap. 12, the acre was fixed as the standard or legal measure of land in Britain. This imperial acre is a square raised from the basis of the chain of 66 ft. or 4 perches, ten of these squares forming the acre, which thus contains 4840 sq. yd. Surveyors in measuring land use a chain 4 perches in length and divided into 100 equal parts called links; and they make their computations in chains and links, but exhibit the result in acres, roods, and perches or poles, 10 sq. ch. or 10,000 sq. links constituting an acre.

The old Scotch acre was equal to nearly 1 ac. 1 rd. and 2 po. or perches imperial; and it comprised 4 roods, while each rood comprised 40 sq. falls, each fall 36 sq. ells, and each ell 9 sq. ft. and 73 sq. in. It was raised from a chain of 24 ells; but owing to the practice of land sur-

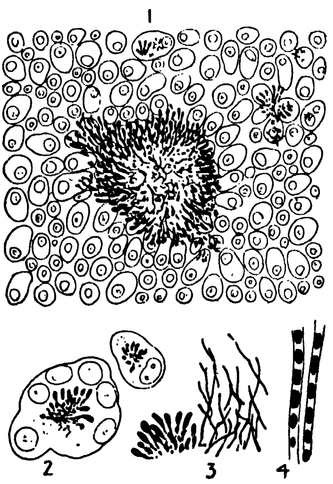
	Square Yards.		Square Yards.	
Statute or Imperial acre	30·25	= 1 perch or pole	4840	= 1 acre
Leicester acre	14·4296875	,,	2308$\frac{3}{4}$	,,
Herefordshire acre	20·16666	,,	3226$\frac{2}{3}$	,,
North Wales customary acre	20·25	,,	3240	,,
Wiltshire acre	22·6875	,,	3630	,,
Devonshire and Somersetshire acre	25·	,,	4000	,,
North Wales *erw* or true acre...	27·	,,	4320	,,
Cornish and Woodland acre	36·	,,	5760	,,
Dumbarton, Banff, and Renfrewshire acre... ...	38·02775	,,	6084$\frac{4}{9}$	,,
Scotch standard acre	38·1508	,,	6104·1279	,,
Inverness acre	38·44	,,	6150·4	,,
Cunningham acre	39·0625	,,	6250	,,
Westmorland acre	42·25	,,	6760	,,
Irish, Lancashire, Churchland, and Plantation acre	49·	,,	7840	,,
West Derby (Lancashire)	56·25	,,	9000	,,
Cheshire, Staffordshire, and Forest acre	64·	,,	10240	,,

veyors measuring with a chain 74·4 ft. in length —the ell having been erroneously estimated at 37·2 in.—the Scots acre came to be about 6150 sq. yd. The old Irish acre is estimated at 1 ac. 2 rd. 19$\frac{1}{10}$ perches imperial. Numerous old local values were given to the acre, but these have for the most part disappeared. The scale on p. 45 shows the number of square yards in the *perch* or *pole* and in the *acre* of the various localities in the table. [J. B.]

Acre-foot. A unit of measurement used in irrigation works. It is an amount of water which would cover an acre 1 ft. deep, and is therefore equal to 12 ac.-in. (see ACRE-INCH).

Acre-inch.—An acre-inch represents the amount of water necessary to cover an acre 1 in. deep; 6 ac.-in. of water would cover one acre 6 in. deep, or six acres 1 in. deep. An acre contains 43,560 sq. ft.; so that 12 ac.-in. is equal to 43,560 cub. ft., and 1 ac.-in. is equal to one-twelfth of that amount, or 3630 cub. ft. As there are 1728 cub. in. in 1 cub. ft., and 277·274 cub. in. in 1 gal., 1 cub. ft. equals 6·232 gal., and 1 ac.-in. equals approximately 22,622 gal.

Actinomycosis. — Actinomycosis, better known as *wooden tongue*, is an ailment caused by the ray fungus (Actinomyces), which is found upon the awns of certain grasses and cereals, and finds its way into the tissues of the animal through abrasions in the mucous membranes, more frequently of the mouth. Cattle are more subject than horses. Swine suffer in the udder, which in these animals is pendulous and close to the ground, and therefore subject to slight abrasions and to greater opportunities of contact with the fungus. The lodgment or infection of the ray fungus is followed by the formation of granulomata, nodules, or tumours on the tongue and jawbones, or in the glands most nearly situated to the mouth. The multiplication of nodules in the substance of the tongue, and the loss of mobility which soon results, has given to the disease the name of wooden tongue. Slavering and inability to take up the food follows upon this condition, and the subjects of actinomycosis soon waste in flesh. Unfortunately the disease is seldom diagnosed until some considerable mischief is done, and the dropping of the food and frothing of the mouth calls attention to the unfortunate animal's condition. Swellings in the glands of the neck, too, are often due to other causes, and actinomycosis is not suspected.



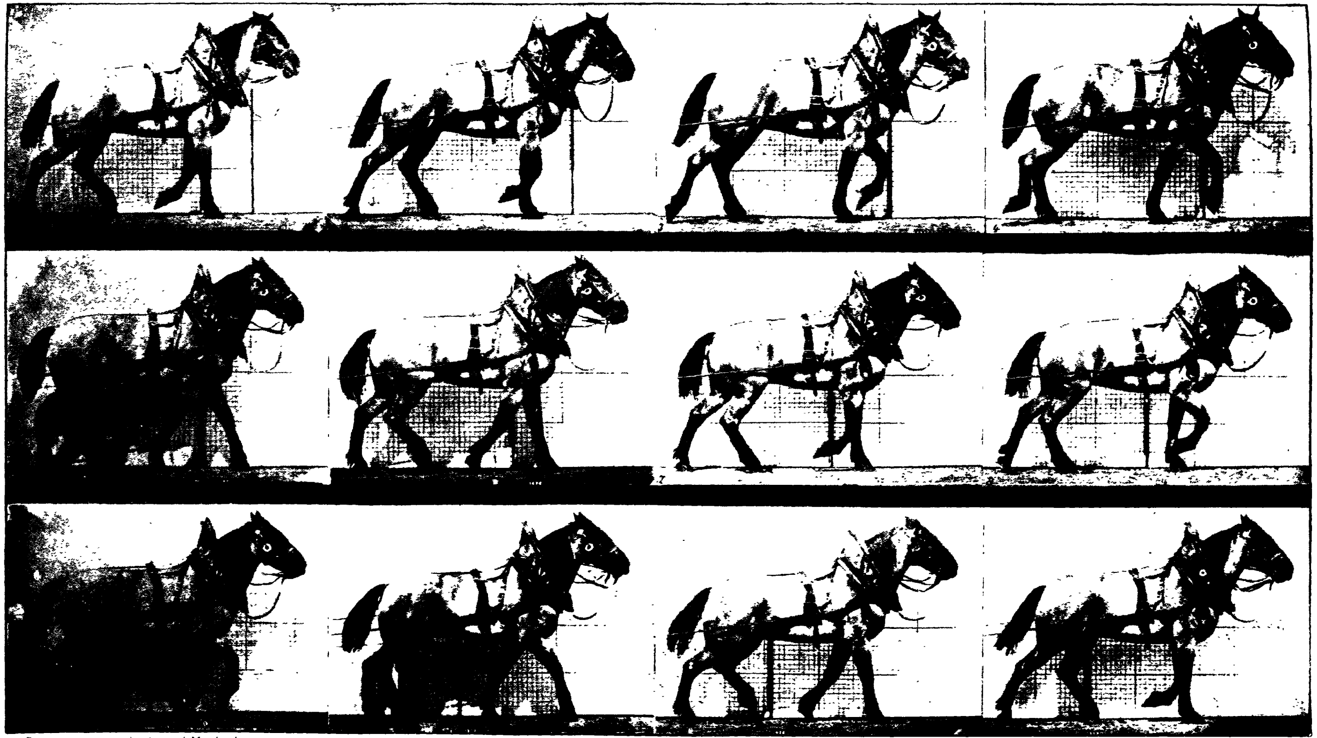
Actinomyces Bovis

1, The fungus on cow's tongue; 2, cell or group of cells with Actinomyces; 3, clubbed filaments and centre filaments of the fungus; 4, filaments from the centre enlarged.

Treatment.—This is usually successful in any but the severest and most neglected cases. The ray fungus cannot live in the same body with iodine; hence we proceed to saturate the patient with the safest salts of that metal in bold doses, increased by degrees as we find him tolerant of the drug, and reduced as soon as its effects are clearly apparent. Iodide of potassium in 4- to 8-dram doses daily for adult cattle, and proportioned to younger animals, has a marked influence in two or three weeks, and often effects a cure in a month, or even less. The tongue or other affected surface should be daily scraped and dressed with a mixture of iodine tincture, carbolic acid, and glycerine, or iodoform. Food of a kind suited to a sore mouth should be offered, and it is found that most beasts will learn to suck up mashes and gruel when unable to use the tongue in the ordinary way. An iodine liniment in soap solution is best calculated to combat the trouble in sows' udders, and the salts of iodine will be taken in food. [H. L.]

Action in Horses. — Action in horses ought, from a breeder's point of view, to be a matter worthy of study and of great importance. The cart-horse buyer wants an animal that will walk well. The purchaser of a hack needs a horse that will walk, trot, and canter well. In the hunting field and on the racecourse a good galloper will be required. Fashion dictates that the carriage horse shall lift his knees almost to his chin, even if he does not get over much ground. Good-moving parents should produce good-moving progeny. The man who breeds good movers, whether carthorses, hacks, hunters, or carriage horses, will reap his reward in good prices for his stock. It cannot, of course, be expected that horses suffering from diseased limbs will have good action, or produce good action in their progeny. Big side bones, fever in the feet, bent legs, splints near the knee, all produce faulty action. Thus it will not be advisable to have any of these faults in the dam, even though the sire be sound and perfect, 'as proud as Lucifer, and as bold as brass'.

What, then, are the characteristics of good action in horses? The walk of *the carthorse* should be straight and free, level and true. His feet should be put down with no uncertain ring. The stride at the walk should be from 3 ft. 10 in. to 4 ft. He should be a good slow trotter, should handle his limbs well at this pace, and his hind feet at each stride should be taken well forward. The stride at the trot should be 5 ft. 6 in. to 6 ft. No class of horse



Copyright 1887 by Eadweard Muybridge.

From *Animals in Motion*, published by Chapman & Hall

PHASES OF THE CART HORSE WALK

should look about him as he goes. If any do, they may be stumblers. As conducers to good action, the feet of the carthorse should be wide and open at the heels and well spread; the pastern not too long and nicely sloped; the horn of the feet not brittle or broken away. Here it may be written that all farmers and breeders should pay attention to the feet of their horses. It pays to do so. Good action is often spoiled by weak, shelly, or long feet, and a bargain lost or less money obtained in consequence.

In *the hack* the walk should be jaunty and springy, bold and not cramped. The trot should be forward and free. The limbs should be thrown well out in a straight line from the shoulder. The hocks should be well flexed, and the hind feet carried well under the body. Every movement should be regular and even, and nothing too exaggerated. The horse and his rider should appear as one, well balanced and well strung. Good hands and a good seat are necessary in the trot to make things comfortable for both horse and rider. A typical hack should be able to lead off with either leg. If he is circling he should always lead off with the leg on the side to which he is curving. There is a gait or action of the horse called ambling or pacing. Apart from military horses it may be seen in this country in imported Russian or Iceland ponies. It is said to be the easiest pace of all for the rider, but looks somewhat unsightly.

In *the carriage horse* the trot is, of course, the chief consideration. The muscles of the forearm and the flexor tendons should be well developed, and for sale purposes perhaps the higher he steps in front the better. Nothing should be out of proportion in him, except, perhaps, his action. His feet should be neither too big nor too small. They should be well shaped, because of the concussion they are subjected to. The invention and use of india-rubber pads have been of great benefit to the carriage horse.

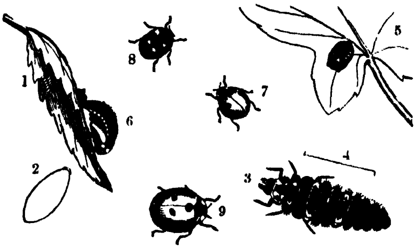
The hunter should canter and gallop well. The former pace should be quickly taken up from the walk, and be performed in an easy and sprightly manner. In *the hunter and racehorse* the gallop may be high or low. Many good horses in the hunting field and on the course travel with their feet little raised from the ground. The feet at the gallop are brought well under the centre of the body, which is propelled forward by both fore and hind limbs, the latter sustaining the greater shock of the horse's body. The hocks in the hunter and racehorse should be compact and strong.

[G. M.]

Act of God. See ACCIDENT.

Adalia bipunctata (the Two-spotted Lady-bird).—One of the commonest Lady-bird beetles. Normally it is red, with a round black spot on each wingcase, but all variations exist, some being black with two red spots. These beetles swarm in the neighbourhood of hop gardens. They hibernate in the adult stage in lofts, outhouses, barns, under bark of trees, &c. Houses are often invaded by them in autumn. They lay their creamy-yellow eggs on the leaves of plants, near colonies of aphides. The ova are attached by one end and are in clusters. The larvæ are known as 'niggers', both they and the adult beetles feed upon aphides of all kinds; when mature the 'niggers' attach themselves to the leaves of the plants and turn to dark-brown and creamy pupæ. They do inestimable good on hops, roses, &c., by clearing off aphis attack.

[F. V. T.]



The Two-spotted Lady-bird (*Adalia bipunctata*)

1, Eggs; 2, egg magnified; 3, larva magnified; 4, larva, nat. size; 5, 6, pupæ; 7, 8, varieties of Two-spotted Lady-bird; 9, Seven-spotted Lady-bird.

Adaptation, Power of, in Animals.—Adaptation is the term used with regard to organisms and their parts when we wish to express their effective functional relations to their environment and to each other. It indicates the suitability of structure to function. According to the theory of Natural Selection, adaptations are brought about by selection, from amongst the numerous variations which arise, of those which are best suited to the needs of the organism under existing conditions. Or to express it somewhat differently, variations provide the raw material for adaptations; all those which are unsuitable are eliminated in the struggle for existence; only suitable variations persist, hence there results an ever greater and greater adaptation of the organism to the conditions of life in which it occurs. Selection thus not only produces adaptation but maintains it. So long as external conditions remain unchanged, selection maintains a *status quo* regarding the structure of the organism, that is to say, it acts in a conservative manner; if they change, from whatever cause, there takes place, through the operation of natural selection, a proportionate structural change. Experimental breeding affords a proof of the correctness of this theory. Here artificial selection takes the place of natural selection, and the new varieties of domestic animals which the breeder evolves are the parallels of the adapted organisms we see in nature which have arisen as the result of the struggle for existence and the elimination of the unfit.

A clear illustration of adaptation may be found in the case of homologous organs of diverse functions. Homologous organs are those which are fundamentally similar; *i.e.* they are the same in original structure and development. Yet their final form may be very diverse. Take the case of the fore-limb of the higher vertebrates. This is a homologous organ; primitively a five-fingered organ adapted for progression upon land. But the uses to which it has been put of necessity in the struggle for existence have led to the evolution of a number of very diverse types of limb, each of them adapted to the special conditions of life in which the organism is placed. Some of the changes produced in such an organ, confining our attention to the skeleton for the sake of simplicity and clearness, are as follow:—1. Changes in the relative length, thickness, &c., of the individual parts. Here are included the development of crests and ridges, tuberosities, &c., or their suppression. An illustration of this is observable in the bones of the bat's wing, which are greatly elongated to serve as a support for the membrane of flight. 2. Reduction in the number of parts, as seen in the limb of the horse, which has now only one functional digit, a change probably acquired in response to the need for swiftness of foot. 3. Union or fusion of parts, admirably illustrated in the wing of birds, where rigidity of certain parts is essential in flight. 4. Multiplication of parts, *e.g.* in the finger-bones of aquatic mammals. 5. Introduction of new parts, as is to be observed in the 'sickle' bone of the mole's paw. Along these and other lines development has proceeded, producing out of the same original structural type the diverse limbs we know in frog, reptile, bird, mole, squirrel, horse, bat, sloth, whale, &c.

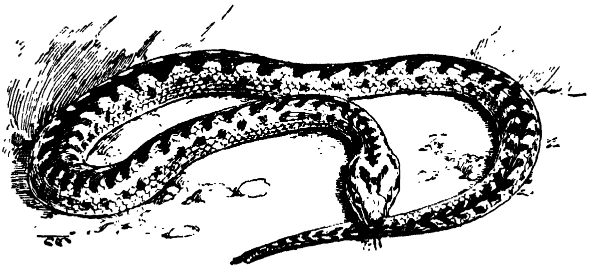
It will be understood from the foregoing that the perfection of adaptations depends upon suitable variations arising and on their hereditary transmission. They are hence termed *phyletic adaptations* (from Greek, *phylē*, tribe, class). These are to be clearly distinguished from *individual adaptations*, which consist of adjustments of the organism *during its life* to changed conditions. They are more frequently changes in habit than of form, although these latter do occur. Perhaps the best-known example is the case of a certain Crustacean, *Artemia salina*, which by means of alterations of the proportions of salt water in its medium has been made to alter its form and assume the characters of two other species, of *Artemia Milhausenii* in concentrated sea water, and of *Branchipus stagnalis* in fresh water. Such adaptations are not of much importance, since, unless acquired characteristics are transmitted, they bear no part in the production of adaptations of the phyletic type. They are to be placed in the same category as the brawny arm of the village blacksmith or the 'horny hands' of the sons of toil. [J. R.]

Adaptation, Power of, in Plants.—The *power of adaptation* may be defined as the faculty of modifying structure and vital functions (or the capacity for admitting of such modifications) in correspondence with a change in the external conditions. This will be better understood by comparing what is said in the beginning of the preceding article, since adaptation in plants is analogous to adaptation in animals. The power of adaptation is developed to a very varying extent in different kinds of plants. From such evidence as is obtainable, it would appear that trees (and perhaps woody plants in general) have a rather smaller power of adapting themselves to a changed environment than herbaceous plants (see especially Heinrich Mayr, Fremdländische Wald- u. Parkbäume für Europa, Berlin, 1906, p. 197 and foll.). The power of adaptation is, moreover, most markedly developed in plants whose organization has not progressed too far in the direction of specialization to suit one particular environment. Those plants which have a highly developed organization (*e.g.* typical aquatics, epiphytes, parasites, &c.) are generally found to have more or less completely lost the power of adaptation to conditions other than those for which their structure specially suits them, although such plants must once have had a great power of adaptation to have attained this extreme. Such far-going adaptation has no doubt in some cases led the plant to place itself at a disadvantage. A good example is found in the flower of the common British Orchids, which probably have the most complicated pollination mechanism to be found among entomophilous flowers, and yet the result of this complexity is that pollination only rarely occurs; similarly, the parasite which has become specialized to the extent of being able to live only on one particular host (*e.g.* many of the rusts), has likewise put itself in a position of disadvantage owing to extreme adaptation. Only such plants are found to have a relatively wide distribution, and to show a considerable power of adaptation to varying conditions, as have not undergone extreme specialization in any particular direction (compare especially the remarks on cereals in the article on acclimatization, p. 16). Good examples are found among the grasses: thus *Trisetum subspicatum* is found in the Arctic regions, the mountains of Northern Europe and Tierra del Fuego, and *Aira flexuosa* has a similar distribution (also *Primula farinosa*); *Phleum alpinum* (and *Erigeron alpinus*) is found in the Swiss Alps, the Arctic regions, and the Falkland Islands. We may sum up this paragraph by saying that the power of adaptation is a property possessed by all plants, but that some have already become so highly adapted to one set of conditions that they are practically unable at the present day to respond to changes in other directions.

The fact that plants have the power to adapt themselves to a change in the external conditions is based on a considerable amount of experimental evidence, of which only a few examples can be mentioned (for others see article on ACCLIMATIZATION OF PLANTS). It is important at the outset to understand that adaptation is probably in most cases a response to the stimulus of several external factors, even where one only appears to be concerned. Thus it has only recently been shown that the marked differences in structure between the sun- and shade-forms of one and the same plant species are due not only to a change in the light-conditions, but also to such factors as wind and available moisture. Similarly the reduction of the prominent features in the structure of a xerophytic plant as the result of cultivation in moist air is no doubt due to the operation of more than one factor. Bonnier's experiments, in which ordinary lowland plants (Dandelion, Rockrose) were cultivated in the same soil at various altitudes, afford particularly instructive examples of the power of adaptation to a new environment. In all cases the effect of the latter was to produce a more or less marked alpine habit, which became more and more pronounced the higher the altitude. The subterranean parts of the plant showed a considerably greater development in comparison with the stunted growth of the subaerial parts, the latter became more hairy and tended to spread out on the surface of the ground, the leaves became smaller and thicker and contained relatively more chlorophyll, and the flowers were relatively larger and had a much deeper colour than in the specimens grown in the plains; the internal structure showed corresponding modifications. The alpine habit became intensified in the course of several years' cultivation at high altitudes, and an almost equally long period elapsed before the ordinary habit was acquired after the modified plant was transferred to the lowlands. Another example of the power of adaptation to changed conditions is shown by the behaviour of submerged specimens of the Lady's Smock; they differ from the ordinary plant in having long-stalked cauline leaves with narrower segments, while the internal structure of the plant approximates to that characteristic of the true aquatics. The submerged Lady's Smock is, however, unable to hold its own amid aquatic conditions for any length of time, but it shows us the line along which a plant like *Polygonum amphibium* has developed; the latter obviously possesses a much greater power of adaptation than the Lady's Smock. On the other hand, the true aquatics (like Water Thyme, Water Starwort, Hornwort) have become so highly adapted to their special environment that they have very little power of adaptation to other conditions (comp. above). All the examples of adaptation as yet given are not difficult to understand from the point of view of their utility to the plant. In other cases we are likewise able to obtain a response on the part of the plant to a variation in the external conditions, without, at present at least, being able to understand the value of the change to the plant. This is particularly true of cases of reversion to the so-called 'juvenile forms', which are often markedly different from the adult form, and can in some cases be fixed if certain precautions are taken (*e.g.* the genus Retinospora, which was established to include various garden varieties of Cupressus, Juniperus, and Thuja, in which the leaves are of the type found in the juvenile forms). For the present it remains doubtful whether such cases are adaptations in the strict sense.

The power of adaptation in plants must be distinguished from the power of variation; the latter is inherent in the plant and may take place in any direction, whereas the term adaptation involves an improvement, suiting the organism better for the conditions of life to which it is subjected, and taking place in response to external influences (stimuli). Adaptations are not as a rule fixed characters, unless the stimuli to which they are due have operated for some length of time (comp. the remarks above on alpine forms of lowland plants). Long-continued action of the stimuli, however, produces adaptations which are hereditary even under abnormal conditions (as in aquatics, parasites, &c.), and it is such hereditary power of adaptation to one particular set of conditions that has led to the evolution of the different biological groups that we recognize at the present day. It seems very probable that the faculty of transmitting the power of adaptation to one set of conditions (*i.e.* to one particular environment) may vary very considerably in different kinds of plants. [F. E. F.]

Adder (*Pelias berus*).—Of the three snakes native to Britain the adder is the only poisonous species. It is a member of the family Viperidæ, all of which are venomous. It is the commonest snake found in Scotland; in England and Wales its distribution appears to be unequal, and it does not occur in Ireland. Except in the northern colder parts it is found over the whole of Europe. As to appearance the adder is somewhat variable in ground colour; sometimes it is dark-brown, but it may be reddish, olive-green, or even grey. It is, however, readily distinguished from other snakes by a set of very distinct markings upon its upper surface. On the back of the head just in front of the neck there is a dark-coloured V-shaped patch, having the apex of the V directed forward, and a broad zigzag line of similar colour running along the back. There are markings along the sides also, but those named are so well defined and so distinctive that they serve alone as a ready and reliable means of identification of this species. In size adders are not known to attain more than 28 in. in length, and are usually several inches below this limit. They frequent, preferably, warm situations, occurring in woods, commons, moorland, and such like places. Favourite haunts appear to be heaps of stones amongst ferns, in holes such as rabbit burrows, and on the top of ant-hills. Their food consists of newts, slow-worms, mice, young rats, water voles, and such like. They are by



Adder (*Pelias berus*)

nature timid animals, and only attack larger animals or human beings when interfered with or when alarmed. The venom, which is used in taking prey or in defence, is secreted by a pair of glands having ducts communicating with the bases of a pair of fangs in the upper jaw. These fangs are perforated, and in the act of striking, the poison is made to flow down the channel within the fang and thus enter the wound along with it. Besides the functional fangs there are reserve ones, which lie concealed behind, and which are brought into use should those in front get broken or lost. The animals which, not being the natural prey of adders, most frequently fall victims to their fangs, are sheep, dogs, cattle, and less frequently mankind. The venom is powerful, and numerous deaths occur every year among dogs and sheep. Although human beings when so unfortunate as to be bitten do not usually die, they suffer seriously, exhibiting all the symptoms of local blood-poisoning as well as experiencing great heart depression. Cases are recorded in which death has resulted, and an adder bite should never be looked upon as other than serious. *Treatment* must be instantaneous and thoroughly heroic. The bite will be indicated as two minute punctures like pinpricks. Free incision should immediately be made at these places, and the wound sucked if there are no cracks or sores about the lips or mouth. The bite is usually upon a limb, and it should be tightly ligatured above the wound so as to prevent absorption of the poison into the system. The first signs of absorption taking place are collapse, followed rapidly by unconsciousness. Large doses of stimulants such as brandy or whisky should be given at once, and continued along with the application of hot fomentations to the wound. The patient must be placed under the care of a medical man without delay. Several weeks or even months may elapse before the effects of the bite entirely disappear. Adders hibernate throughout the winter, and pair in the months of April or May. They are viviparous, that is to say, the eggs are not laid, but retained within the body of the mother until the young are hatched. They are thus brought forth alive. [J. R.]

Administration of Medicines. See MEDICINES.

Adobe.—A Spanish name for an unbaked brick, now applied in America to a material which is probably the same as löss (see art. Löss). In texture adobe is a clay, commonly light-yellow, and consisting of very minute particles derived from the rock masses round about. Shales on mountain sides may thus give rise, through the wash of rain and the transporting action of wind, to adobe in the valley floors below. The materials are commonly little altered. Fine quartz sand preponderates in some adobes; others contain much carbonate of lime. The American deposits represent in part the sediments of lakes that have disappeared throughout the rainless regions. The accumulations of adobe in Mexico, Colorado, &c., are sometimes over 3000 ft. deep, and only require water to provide soils of great fertility. (See especially I. C. Russell, 'Subaerial Deposits of N. America', Geol. Mag., 1889, pp. 291 and 342.) [G. A. J. C.] [T. H.]

Adonis autumnalis (Corn Pheasant's-eye).—It is related in Greek story that when Adonis was wounded by the boar, the blood which dropped on the ground changed into a scarlet flower which they called after him Adonis. Pheasant's-eye is a small native annual weed of the Buttercup family, easily recognized by its finely divided leaves, by the solitary flowers with scarlet petals, and by the netted achenes. It may be found growing among corn, or on any dry exposed land. [A. N. M'A.]

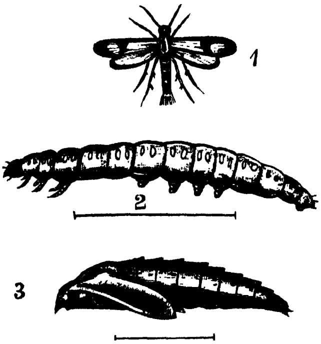
Adrastus limbatus (Strawberry Click-beetle).—The wireworms of this beetle bore into strawberry fruit in Ireland. It is a small Clickbeetle about ¼ in. long; head and thorax shiny black, the latter with pale-grey pubescence; antennæ, legs, and elytra pale ochreous yellow. It especially occurs in grassy places in woods and clearings. [F. V. T.]

Adulteration.—A term applied to the fraudulent mixture of articles of commerce with noxious or inferior ingredients, the aim being to increase the profits of the vender. This practice is common in connection with the business of agriculture, the farmer, as the purchaser of the adulterated product, being almost invariably the sufferer. A common practice in the sale of commercial fertilizers is to substitute some cheaper but less effective form of the same manurial ingredients, while feeding stuffs are often adulterated with cheaper materials of lower feeding value. Grass and clover and other seeds are also sold which contain admixtures of those of cheaper varieties, or of weed seeds of similar appearance. On the other hand, dairymen sometimes contrive to increase their profits in an illicit way by supplying to consumers milk to which water has been added or milk from which fat has been abstracted. See FOODS AND DRUGS ACTS, FERTILIZERS AND FEEDINGSTUFFS ACTS, ANALYST, MILK, ETC.

Ægeria myopæformis (the Apple Clearwing).—A moth very similar in appearance to the Currant Clearwing Moth (see next article), but it can at once be told by the bright-red band above on the abdomen, which is white beneath in the male, only edged with white in the female. They frequent gardens and orchards in May, June, and July, when they lay their ova on the trunks of apple trees. The larvæ tunnel under the bark of the trunk and boughs, eating out cavities in the wood until they mature. The larvæ are dull yellowish-white and may have a pinkish tinge, and measure ⅗ in. in length; they pupate in June as a rule. Rich brown wood chips and 'frass' mark their workings on the trees. Sometimes much harm is caused by them on young trees.

Treatment consists in smearing sticky dressings on the trees to prevent egg-laying, and cutting out the larvæ, which can be detected by the 'frass'. [F. V. T.]

Ægeria tipuliformis (the Currant Clearwing).—Black currants are frequently damaged by this insect. It belongs to the family of Clearwing Moths or Ægeriidæ. The moth is about ⅔ in. in expanse of wings, which are transparent, with black fringes and a black bar across the front pair, the ends with black veins and a yellowish sheen; body and thorax purplish-black, the former with yellow bands and a black fan-like tail. They appear in May and June, and lay their ova on twigs and buds The caterpillars make their way into and tunnel up and down the shoots and kill them; they are creamy white, and mature in April, reaching ¾ in. in length. Pupation takes place in a loose cocoon of silk in the tunnel. The brown spiny pupa forces its way out of a small hole, and the moth escapes. They may also attack red currants and the gooseberry. *Treatment* consists in pruning off infested wood. [F. V. T.]



1, Currant Clearwing Moth (*Ægeria tipuliformis*); 2, Larva; and 3, Pupa, magnified

Ægopodium, a genus of plants of the family Umbelliferæ to which the plant commonly known as Bishop's Weed belongs. See Bishop's Weed.

Aeration.—The act of causing a substance, such as soil or milk, to become intimately mixed with air or any gas. Aeration is usually effected in order to allow the oxygen of the atmosphere to induce desired chemical changes, and in this restricted sense the act is termed *oxygenation.* Aeration is also commonly effected by means of carbonic acid gas. Thus the basis of effervescent beverages is water impregnated with this gas. Aerated bread receives its sponginess or porosity from carbonic acid gas supplied artificially and not produced by the fermentation of yeast.

Aerators, Milk.—The common type of milk aerator consists of a small perforated trough, which allows the milk to run over a sheet of coarse wire gauze which is suspended vertically; from the bottom of the gauze the milk runs into another trough, from which it passes to a vessel underneath. It is generally used in conjunction with the milk cooler, the processes of cooling and aeration being performed in one operation. They should be used in the open air, in a place where there is as little dust as possible. The cleaning of milk aerators requires to be very thorough, as the interstices of the wire gauze, particularly the places where the wires cross, tend to hold minute amounts of milk which turn sour, and unless removed taint the milk. The aerator should be frequently taken down and boiled in soda water, and afterwards well washed in clean water.

Milk aerators are also employed in conjunction with pasteurizers. Milk is frequently pasteurized which has been drawn from the cow for some time, and by the action of micro-organisms unpleasant odours are sometimes developed. The process of pasteurization destroys the micro-organisms, and aeration is resorted to, to remove the odorous products; on a large scale it is not unusual to draw air over the milk spread out on a large surface by means of a fan. Cream is also sometimes aerated after passing from the separator, though not very frequently, as the rapid revolution of the bowl of the separator causes a draught to pass through the cream outlet pipe, which has the practical effect of aeration.

In the opinion of many, milk is improved both in flavour and keeping qualities by aeration as soon as possible after milking; on the other hand, others maintain that this is a fallacy, and that aeration does more harm than good, in that the milk is exposed not only to air but to dust and dirt, and that the milk aerator with its large surface is difficult to keep thoroughly clean.

It is probable that both sides of the question have a certain claim for hearing; milk readily absorbs odours, and when the cows are milked in close, dirty sheds, which are often foul-smelling, the process of aeration will have some effect in removing the unpleasant taint. When proper cleanliness is observed, milk requires no aeration, and the less it is exposed to air the better.

Milk aerators, therefore, are only of use to improve bad milk, and their use is only a make-shift; the true remedy for the faults that they rectify is greater cleanliness.

The term milk aerators may also be applied to machines by which milk is charged with carbonic acid and other gases under pressure. These are of the same type as those used for the preparation of mineral waters. Milk charged with carbonic acid gas will keep considerably longer than ordinary milk. [H. D. R.]

Aerobic Bacteria, Aerobics.—Bacteria which require a supply of free or uncombined oxygen for their existence. See Bacteria.

Æsculus, the genus of trees to which the Horse-chestnut belongs. See Horse-chestnut.

Æthusa, the genus of plants to which Fool's Parsley belongs. See Fool's Parsley.

Afterbirth.—The placental membranes or envelopes in which the unborn creature is contained. These serve the purpose of a water bed or cushion to protect him from injury during the movements of the mother, and from external violence, such as might be experienced from falls or blows. In ruminants it is attached by a number of cotyledons or 'roses', and the fœtus derives nourishment through them as well as through the blood-vessels of the umbilical cord, which is the chief supply in solipeds and other animals. When labour commences, these membranes are first protruded in bladder-like form, and to serve the useful purpose of distending the passage for the advent of the new-comer. It is best that they should rupture naturally, when a large amount of fluid is released, and the young creature follows by the expulsive efforts of the dam. This accomplished, the afterbirth, placenta, or cleansing, as it is variously called, should follow.

In the case of mares, labour is of short duration. The foal is quickly born, and the afterbirth follows in corresponding time, if all goes well. In the case of cattle and sheep a much longer time is commonly occupied in parturition, and the placenta is proportionately long retained, its attachments, alluded to above, offering some hindrance to immediate separation. What has been said of cattle applies also to sheep. Parturition may extend over many hours, and even days, without death of the fœtus in ruminants, but in mares it is generally believed that two hours is the longest labour in which a live foal has been produced. A few minutes usually suffice for delivery if all is well. In a state of nature, mothers usually devour the afterbirth. It affords them immediate sustenance under conditions in which they may not go abroad to seek their food, and besides, it obliterates evidence which might be utilized by beasts of prey. The instinct often survives in domesticated animals, whose digestive functions have been so altered by generations of protection that illness results from indulgence of the practice. It is therefore deemed advisable to remove and bury or burn the placenta. Retention of the placenta, or 'not cleaning' as it is called, is a common trouble, more particularly with ruminants. If birth is premature, or abortion occurs at any period, the disposition to retention is always greater than where the full period of gestation has been fulfilled.

Manual interference is permissible and even desirable under certain circumstances, but the process of separation from the parent should not be hurried. If a person is present at the time of parturition he may do well to ligature the umbilical cord close to the belly, for reasons which will be referred to in connection with diseases of that structure; and if a mare does not part with the placenta in a few hours he may exercise gentle traction upon it with a hand previously prepared by antiseptic washing, but any serious resistance should be accepted as a warning to wait or to use other means. Cows and ewes have died from hæmorrhage, as the result of too early and forcible removal of the membranes. If separation is not naturally effected the day following parturition, a small amount of force may be used to detach the placenta; it may be all that is needed, or the afterbirth may have been caught in the neck of the womb by premature closure of the *os uteri*. In such cases it is well to attach a weight to the extruded portion, and day by day give another turn or twist, while flooding the uterus with warm antiseptic washes, paying particular attention to the placenta where it rests upon the floor of the vagina, and holding it up while that portion receives plenteous irrigation. In multiparous animals, as sows and bitches, the placenta of each fœtus is extruded soon after its birth by the succeeding fœtus; so that if retention occurs at all, it is only the last or the two last placentæ which remain.

[H. L.]

Aftermath, the second mowing of grass. After the ordinary hay crop has been taken off, the grass of course begins to grow again, more or less according to circumstances, and a fair amount of stuff may show itself by the time the corn harvest is finished. This aftergrowth is called rowen, rowett, eddish, fogg, and foggage in different parts of the country, and the name is usually confined to the produce of perennial grass fields or meadows: the second growths of 'artificial' grasses, clovers, lucerne, &c.—which are generally fairly bulky and are cut for haymaking during or after the harvesting of the corn crops—are not designated by this name. If it is strong and bulky it might be cut for a second crop of hay, but it is very unusual to do so unless in exceptional cases, such as we meet with on water (irrigation) meadows.

To ensure a good show of aftermath the best plan is to cut the first crop rather early than late. The longer the first crop is left on the ground the poorer as a rule will be the aftermath. It is a mistake to leave the first crop too long, in the fallacious belief that it will have a better 'bottom', because the stems become withered and rotten at the ground, and the roots may be so much impaired as to seriously lessen the aftergrowth.

It is not advantageous to cut the aftermath, although it is practised to a great extent in districts where lambs are suckled. More care is necessary in the mowing than with the first crop, on account of its lightness. It will mow best early in the morning before the dew is off, for the knives will pass over the grass without fairly cutting it if it is very dry. The grass is soft and woolly and has no body in it, as it has had no time for the sun to harden it.

It is a precarious business making aftermath into hay as compared with the harder artificial grasses, for it will necessarily be late in the year. The autumnal dews combined with the shortening days and succulent nature of the herbage are all against it. It must be well made, more so than the first cut, as it is more liable to become musty and mildewed and will consequently be rejected by stock.

There is a prevailing fallacy that it is of more value as hay than the first crop, as it chiefly consists of late-growing grasses, which are supposed to be specially nutritious. This is wrong, however, for it is neither so good in either quantity or quality. It is only in exceptional circumstances, therefore, that aftermath is made into hay.

It makes good silage. It is far better husbandry, however, and a plan more generally practised, to leave it on the ground and graze it off.

When grazed off it is usual to let it grow a little before the stock is turned on to it. It suits all kinds of stock, but it is particularly valuable on a dairy farm as supplying some succulent food when the regular pastures have become bare, and thus helping up the yield of milk from the cows.

In some parts of Wales it is the custom to let it grow and wither down, and thus become 'self-cured' hay, and then the stock is turned on in winter time and find sufficient food to keep them going, without any hand feeding. This practice can be successfully followed in any southern or sheltered district where outside wintering of stock is customary, and there is not too much frost and snow. [P. M'C.]

Agaricus.—An important genus of fungi, containing the Common Mushroom and others.

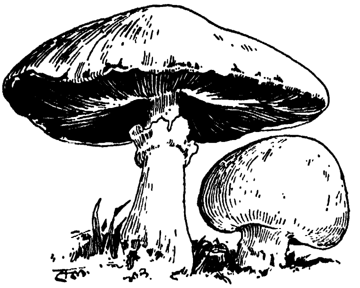


Fig. 1.—Common Mushroom (*Agaricus campestris*)

The higher fungi are divided into several classes, one of which is the Basidiomycetes, whose chief distinguishing feature is the production of a small definite number of naked spores—two, four, six, or eight usually—borne on very slender processes, the *sterigmata*, at the end of large terminal cells termed *basidia*. This class includes, among others, puff-balls, toad-stools, and many bracket-like fungi met with growing on trees. One group of the Basidiomycetes, known as the Hymenomycetes, is characterized by having the spore-bearing surface, or *hymenium*, of the fungi naked and exposed to the air when ripe. There are several families of Hymenomycetes, included in one of which is the genus Agaricus.

In former times, when the scheme of classification adopted by Fries was prevalent, the genus Agaricus embraced some thousands of species, all resembling in many respects the structure and appearance of the Common Mushroom, with its stalk, cap, and gills. At the present day, the genus Agaricus includes a comparatively small number of species, with brownish or reddish-purple spores borne on gills which at first appear whitish or pink. The chief British representatives are the common wild mushroom (*A. campestris*, L.), the Horse Mushroom (*A. arvensis*, Schæff.), *A. elvensis*, B. and Br., *A. silvaticus*, Schæff., *A. pratensis*, Schæff., and five or six less familiar species. The Common Mushroom, which grows in open pastures, has an underground mycelium or spawn, upon which are developed the sporophores or fruits. At first the mushrooms appear as small round bodies like white peas. Subsequently they grow at a rapid rate under suitable conditions, and when fully developed possess: (1) a short stem or *stipe* often somewhat thickened at the base, (2) a flat umbrella-like cap or *pileus*, on the under side of which are (3) a series of radiating flat gills or *lamellæ*, upon which the purplish-brown spores are produced. On the stem there is generally visible (4) a frill or ring, the remains of a thin membrane—the *partial veil*—which extended from the stem to the edge of the cap, and covered the gills when the mushroom was young. The Common Mushroom grows in open pastures, rarely near trees or bushes, and is usually about 3 to 5 in. in diameter, with gills which change from a salmon-pink to a dark purplish-brown when ripe. A large number of forms or varieties are known, of which *A. hortensis*, the cultivated mushroom, is one, grown extensively for commercial purposes (see MUSHROOM). The wild mycelium, or so-called 'virgin spawn', used for the inoculation of prepared beds of manure, is obtained from pastures, meadows, old compost beds, and similar natural sources. Many attempts have been made to develop an active spawn from the spores of the fungus, but without much success. The spores germinate very irregularly, but recent investigations have shown that they may be stimulated into growth by the presence of small portions of living mycelium, the active agent being probably some enzyme secreted by the latter. Dilute solutions (½ per cent) of potassium magnesium, ammonium phosphate, and magnesium phosphate also act as stimuli on the spores of the Common Mushroom. From germinated spores transferred to sterile media it is possible to produce vigorous virgin spawn. It has been found also that spawn may be developed from selected mushrooms possessing desirable qualities by

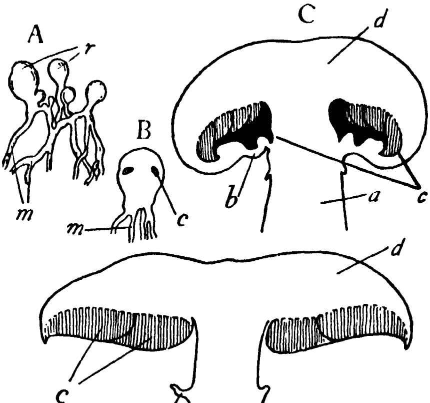


Fig. 2.—A, Portion of the Mycelium, *m*, of the Common Mushroom (*Agaricus campestris*), with young 'mushrooms' *r*. B, Longitudinal Section of Young Mushroom. *m*, Mycelium; *c*, points where lamellæ are developed. C, Longitudinal Section of a Half-grown Mushroom. *a*, Stipe; *b*, the veil (*velum partiale*); *c*, lamellæ or gills; *d*, fleshy parts of pileus. D, An Older Stage of C. (All slightly enlarged.)

taking small pieces of the tissue of the young caps or pilei and transferring them to tubes of sterilized manure or decayed leaves. In this way strains of good types may be preserved and multiplied.

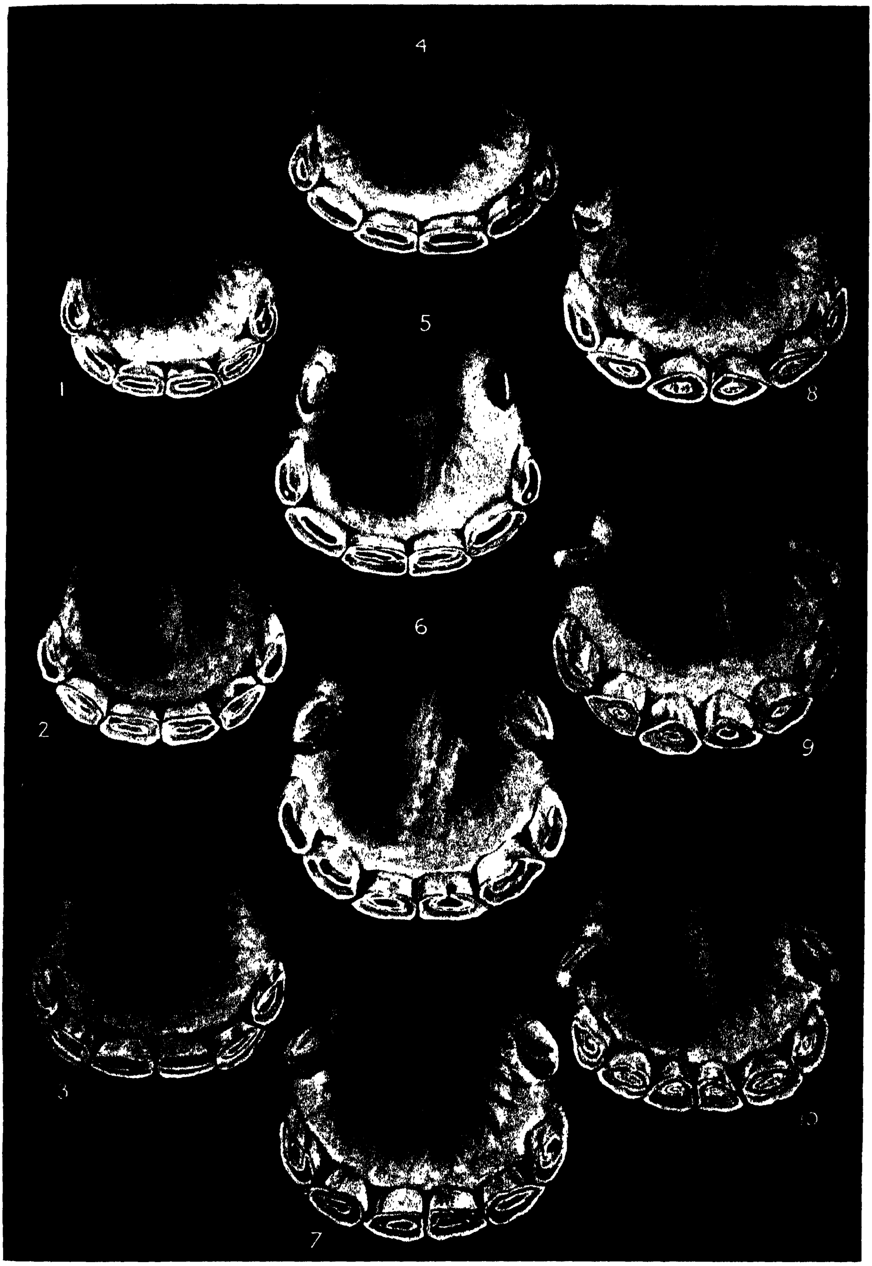
The Horse Mushroom (*A. arvensis*) grows often in large rings in pastures, and is usually much larger than the Common Mushroom, with a more fleshy pileus and almost white gills. When bruised it becomes yellow, the stained bruised patches on the Common Mushroom being reddish-brown. It has a strong, unpleasant smell. When young it may be eaten, but becomes tough and indigestible with age. *A. silvaticus*, which grows in woods, is much the same size as the Common Mushroom, with reddish-brown gills, thin flesh, and a hollow stem which is not thickened at the base. *A. elvensis* is met with under oak and other trees. It is a delicious, somewhat rare species. Pileus from 4 to 6 in. across; gills brownish, with thick flesh which turns red when bruised. The stem when fully grown generally has a thickened, bulging centre. See also art. MUSHROOM. [J. F.]

Agave (*Agave americana*)

Agave, a large and important genus of the nat. ord. Amaryllideæ indigenous to Mexico and Central America, where the common species, *A. americana*, is known as the Maguey or 'tree of wonders', and is one of the most important economic plants. Introduced into Spain in 1561, it is now widely acclimatized along the Mediterranean coasts, as well as in most tropical and sub-tropical countries. Its chief product is the fibre obtained by maceration from the leaves and roots, and known commercially as American Aloe, Pita flax, or vegetable silk. This trade name is apt to cause the plant to be confounded with the true or bitter Aloe (see ALOE), which it resembles in having a crowded whorl of thick, fleshy, prickly leaves, but from which it differs in that the majority of the species have only a short stem hardly rising above the level of the ground. The true Aloe being a member of the nat. ord. Liliaceæ, the chief botanical difference is in the position of the ovary, this being superior in the Aloe and inferior in the Agave. In Mexico the Agave flowers at from five to twelve years of age, a large flowering shoot being thrown up to a height of from 12 or 15 to 30 or even 40 ft. After flowering and seeding the plant dies; but suckers are thrown out from lateral buds on the roots, so that the death of the aerial parent shoot provides an immediate progeny. In the temperate climate of Southern Europe and Northern Africa flowering only occurs at longer intervals, and in hothouses in Britain it may even be delayed till eighty or one hundred years of age—hence its popular name of the 'Century plant'. In warm climates it grows best in a dry and gravelly soil, and is easily propagated by separating and transplanting the young one- or two-year-old suckers. In Mexico these are usually spread on the ground for two or three months to partially dry them, as they are apt to rot if planted out at once. They are then set in rows at from 2¾ to 5 ft. apart (1750 to 5000 per acre), and the leaves are afterwards cut at from three or four years of age, the cutting continuing for four or five years till the plant flowers and dies. The cut leaves, varying up to 5 or 7 ft. in length, are in Mexico either steeped in water, then beaten and scraped to remove non-fibrous portions, and washed and sun-bleached, or else lopped at the pointed end, then beaten, tied in bundles, laid in heaps, and allowed to ferment, after which they are again beaten, macerated in water for fourteen days, and then finally washed and sun-dried. In India they are crushed by machine to break the hard surface and express the juice, then pounded with a wooden mallet till all the ligneous matter is removed, washed free from sap and dirt, and sun-dried for use. The plant yields a coarse but strong fibre, largely used for ropes, twine, hammocks, &c., and it is also a good material for paper-making. The sliced leaves are sometimes used fresh as a poultice and as fodder, and their expressed juice forms an alterative and resolvent medicinal drug; the roots also are diuretic; the sugary, sourish sap (aguamiel) of the flowering shoot ferments rapidly and forms the pulque beer of the Spaniards, or is distilled into an intoxicating spirit (Mezcal or Aguardiente). [J. N.]

Agent, Land.—One can best form an idea of the qualifications required of the man who would be a successful landagent when he is made aware of what the duties of the agent are. We are referring at present to the resident agent or estate manager; not to the surveyor and valuer who in England manages estates at so much per cent on the rental, nor to the law agent who in Scotland manages estates from his office in town. We mean the man whose time is fully occupied with the affairs of the estate

AGE OF ANIMALS— I



DENTITION OF THE HORSE

1, Incisors of Colt at one year; 2, Incisors of Horse at two years; 3, Incisors at two-and-three-quarter years; 4, Incisors at three-and-a-half years; 5, Incisors at four-and-a-half years; 6, 7, 8, 9, 10, Incisors at five, six, seven, eight, and twelve years.

he is in charge of. His duties are in general to see that the estate is kept free from dilapidations—that buildings, fences, roads, and drains are kept in good order; to see that the tenants are working according to the rules of good husbandry; to see that the plantations are managed on right lines; and of course to attend to the daily routine of office work in so far as correspondence bookkeeping, and the preparation of plans are concerned. And over and above there is more or less of the public business of parish and county to be dealt with. Accordingly as estates vary in size do the agents take more or less of the actual work on their own shoulders. Up to a certain point the competent man can easily undertake the burden himself; beyond that he must of necessity have assistance in the carrying out of details as well as in general supervision.

It is clear, therefore, that the estate manager, besides being a fair office hand, must be a bit of an architect and civil engineer as well. Moreover, he must be acquainted with the principles and practice of agriculture, else he cannot meet on equal terms with farmers in matters of business. And he must know something about forestry. He must have these qualifications before he can be expected to be in the front rank of his profession. And even possessed of these, unless he be in close touch with country affairs, and is in full sympathy with the lives of the tillers of the soil, his success will at all stages be more apparent than real. An agent, if so disposed, can do much to ameliorate the lives of the labourers on the estate. Farmers can look after themselves; but, as a rule, the farm hands have few to take an interest in them and endeavour to make their home life a little more comfortable.

The estate manager's practical knowledge of building matters need not be very profound. So long as he is able to prepare a plan and specification which a builder can follow clearly, he will pass muster in this connection. He can only be expected to deal with farm buildings and houses with no pretension to architectural features. Utilitarian erections fall to his lot; where embellishment is called for, the services of the architect may be sought. He must, however, have a good knowledge of sanitary matters. Neither need his skill in engineering be very great. If he can use the level and plot a section from the field book, he will be in a position to lay off projected drains and water supplies, estimate the cost of proposed roads and embankments, and so on, which is about as much as may be expected from him. And nearly all the surveying he may have to do will be more or less in conjunction with the maps of the Ordnance Survey. His knowledge of building on the one hand and of forestry on the other will serve to guide him in the matter of fences.

Constant attention to details tends more to success in estate management than intermittent heroic measures ever can do. A few years' slackness of oversight soon shows its effect; and very depressing it is to see the good work of a competent man being wasted through neglect on the part of his successor. It is an expensive business bringing dilapidated buildings and fences back to good repair. A comparatively small annual outlay may keep them in repair, but once out of hand they are not easily restored to good condition. A falling off such as we refer to can easily occur through want of knowing better on the part of the man in charge; but any retrograde step of this kind is unpardonable to the man with the training above defined.

Where is this training to be had? may with good reason be asked. Unfortunately there are, so far, no institutions specially devoted to the training of the young estate agent. Indeed there has been no pronounced demand for anything of this kind, landowners as a rule not bothering themselves about technical education regarding the economies of landed estate, either on their own account or on that of their respective deputies in estate management. Estate management is surely, however, the last of the great industries, if we may use this term in connection therewith, that is content to leave its exponents to jog along without any special training. Ere long, landowners in general will be aroused to the fact that landowning is a profession, and will require to be accepted as such if they intend to hold their position in the country. Those who have already read the signs of the times, and are devoting time and thought to the welfare of their estates and the dwellers thereon, find most interesting occupation in so doing. Meantime those who are anxious to qualify as paid estate managers have to pick up the necessary knowledge as best they can. The routine work they can become accustomed to in the office of any efficient manager, if lucky enough to get into communication with such. Under him they may also be able to acquire enough knowledge regarding building construction and field engineering as applied to farm and estate work to serve their purpose. But elsewhere they must go for knowledge of the sciences that are involved in their calling. This they find, in company with the embryo farmer in search of mental food of the same kind, at the colleges of agriculture. More or less completely, the leading agricultural colleges are including in their curriculums courses of study adapted to the requirements of land agents. Much will always, however, have to be learned in the office of the land agent and in the actual work of estate management. The colleges can only lay the foundations of a thorough training, which must be completed in actual work. [R. H.]

Age of Animals.—The teeth of animals are used to grasp their food and masticate (*i.e.* to cut and grind) it, but from times long past they have also furnished inquisitive man with an indication as to age. In the case of the horse and cow, the most valuable of stock, the judging of age by the teeth has become a matter of reasonable exactitude; so also has it in the case of the pig and sheep; but as regards man's friend, the dog, it is another matter, which will be mentioned later on.

Teeth are hard structures growing from cavities in the bones of the jaw called alveoli, through soft tissue called the gums, into the mouth. They are composed of three substances, enamel, dentine, and *crusta petrosa.* Looking at an extracted tooth, we recognize also a crown, a neck, and a fang or root. There is a cavity running into the tooth called the pulp cavity, which as age advances gradually disappears. The enamel is insensitive. It is present in greatest quantity in the teeth of the pig, dog, and cow, but is wanting in a good part of the crown of the teeth of the horse. Disease or injury of the dentine, *crusta petrosa*, or pulp cavity causes toothache. Disease of the horse's teeth seldom causes destruction of their crowns. The decay takes place between the teeth, and often between the 4th and 5th, or 5th and 6th molar in the bottom jaw.

The teeth, according to their shape and situation, are distinguished as molars or grinders, incisors or cutting teeth, and tusks, tushes, or canine teeth. They are arranged in the closed mouth as two horizontal arches, separated in the case of the upper by the palate, and the lower by the tongue.

Horse.—Two sets of teeth develop in the horse: temporary or milk teeth, and permanent teeth. It may be written that the temporary teeth in all animals are whiter than the permanent, smaller, and have a narrower neck. The age of thoroughbreds is calculated from January 1, and of other horses from May 1. The common parlance of a figure followed by 'off', such as '5 off', means over five years old, whilst a figure preceded by 'rising', as 'rising 5', means not quite five.

The incisors according to their position are termed central, lateral, or corner. A foal at birth has 2 central temporary incisors in each jaw, and in six or eight weeks has 8 temporary incisors (4 in each jaw), the lateral incisors having appeared. He has 12 temporary molars at birth, or soon after; at nine months old 4 more temporary incisors (the corners) will be up, and at one year old the 1st permanent molar tooth will be up, but its surface will not be worn, and the recent appearance of this tooth will furnish good evidence as to a foal being one year old. At one year old, therefore, a foal will have 12 temporary incisors, 12 temporary molars, and 4 permanent molars.

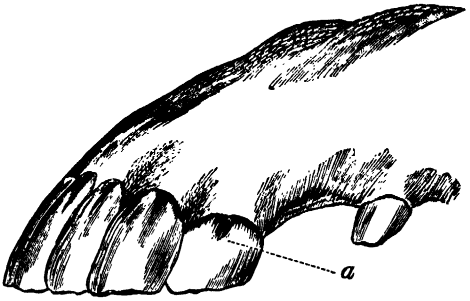


Fig. 1.—Groove (*a*) at the side of Horse's Upper Corner Incisor at ten years

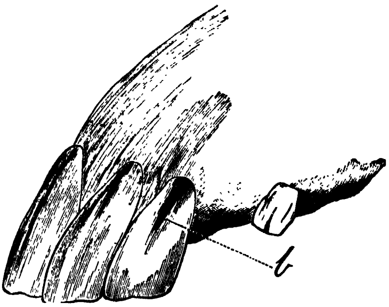


Fig. 2.—Groove (*b*) reaching half-way down the Corner Incisor at fifteen to sixteen years

Between the ages of one and two the temporary incisors wear down. At one year and six months the 2nd permanent molar, the fifth in the jaws, makes its appearance, and at two is up and in wear.

At two years and nine months the central temporary incisors fall out, and the permanent incisors may be seen coming through the gums, and are up and in wear at three years old.

At two years and six months, two more permanent molars appear, the 1st and 2nd in the jaws. The young animal at this time has 8 temporary incisors, 4 permanent incisors, and 20 molars (permanent 16, and temporary 4).

About the age of three years and six months the lateral incisors appear, and are up and in wear at four years. The 5th and 6th permanent molars also appear at about this time. Thus at four years old there are 24 permanent molars and no temporary molars. At four years and six months the corner incisors appear, and are up and in wear at five years old.

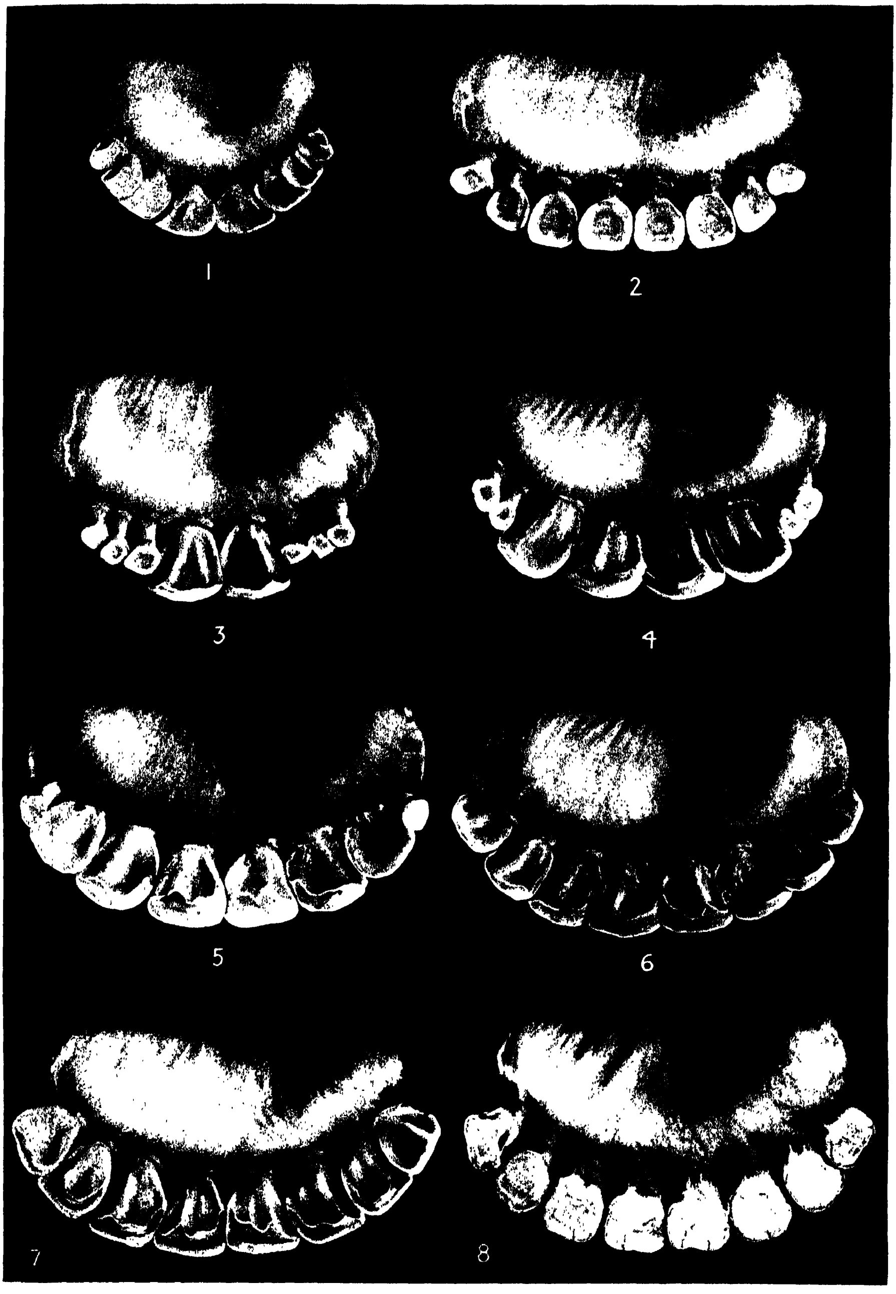
The canine teeth or tushes, absent in mares, appear at about four and a half years old, and may be up at five. They only make their appearance as permanent teeth, and often appear later in the upper than in the lower jaw.

On the crown surfaces of the incisor teeth, cavities called infundibulæ or marks may be seen. These marks, their presence and disappearance, are the chief means by which a horse's age can be told after five. At six years old the marks are disappearing out of the central incisors. At seven the marks of the laterals are going. At eight the marks are departing from the corners.

At seven years old the horse has usually a triangular notch in the upper corner incisor. At about nine years old the marks disappear from the central upper incisors; at ten from the laterals, and at twelve there are no marks in the upper incisors.

After eight years it is hard to tell the exact age of a horse. An Australian horse-breaker (Galvayne) has given a fairly good guide, however. On the upper corner incisor a groove begins to appear at ten years old. At fifteen it is half-way down the tooth. At twenty-one it is down to the bottom of the tooth. (Figs. 1-5.)

AGE OF ANIMALS- II



DENTITION OF THE OX

1, Incisors at one month; 2, Incisors of Steer, one year; 3, Incisors at one year and te
to two-and-a-half years; 5, Incisors at two-and-a-half to three years; 6, Incis
7, Incisors at four-and-three-quarter years; 8, Incisors at ten years.

An aged animal sometimes has a mark burnt in his corner incisor to make him pass as an eight-year-old. This is called 'bishoping' because first practised by a man of the name of Bishop (see art. Bishoping).

A horse's incisors sometimes make him four years old on the near side and five years old on the off, or vice versa.

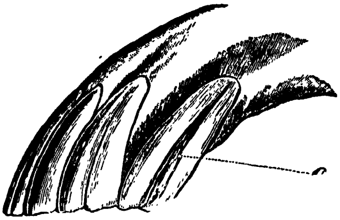


Fig. 3.—Groove (e) extending the whole length of the Corner Incisor at twenty-one years

A foal has a frizzy mane and tail, long legs, and small feet.

As he becomes older he is called a colt if a male, and a filly if a female.

An aged horse has deep hollows over his eyes, and grey hairs about the eyes, muzzle, and mane.

The horse tribe seize and cut food with their incisor teeth.

Cow.—The teeth of the ox are 32, 8 incisors and 24 molars. The incisors are markedly broad at the crown and narrow at the neck. There are no incisors in the upper jaw. There is, however, a dental pad against which the lower incisors play. The incisors are movable. The temporary incisors and molars are up very soon after birth.

At about a year and a half to two years the central permanent incisors are up. At about two years and a half the internal laterals appear. At about three years the external laterals. At three years and six months the corners are up.

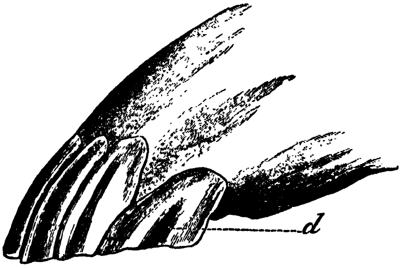


Fig. 4.—Groove (d) grown down from the Gum, leaving the upper part of the Tooth smooth at twenty-six years

The 1st permanent molar appears at six months, and all of them are up at three years old.

The horns of cattle are a guide to their age. We generally allow three years for the tip and a year for every ring on the horn.

Dairymen, when buying cows, judge of the number of calves they have had by the rings on the horns.

Cattle draw food into their mouths with their tongues, and cut it off against the dental pad with the incisors.

Sheep.—Lambs are generally born without teeth. At a month there is a full mouth of temporary incisors, and the teeth number 32 in all.

Permanent incisors up.—One and a quarter years, 2 centrals—a shearling. One and a half years, 2 middles. Two and a half years, 2 laterals. Three years, 2 corners.

Molars.—1st, 2nd, and 3rd temporary molars are present at a month. 1st permanent molar, the fourth in situation, appears at three months. 2nd permanent molar, the fifth in situation, at nine months. 3rd permanent molar, the sixth in situation, at eighteen months. The 1st, 2nd, and 3rd temporary molars are replaced at two years.

Pig.—The pig has 6 incisor teeth in the upper and lower jaw. Next to these come the tusks, one on each side in the upper and lower jaw.

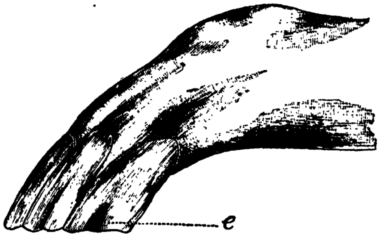


Fig. 5.—Groove (e) nearly worn out, upper part of Incisor round and smooth, at thirty years

Between the tusks and the molar teeth are 4 small teeth called premolars, which are never temporary. The pig has 24 molars. At birth he has 2 sharp-pointed teeth, representing the temporary tusk and corner incisor, one each side of the front of the jaw.

At one month the 12 temporary molars are out, the second and third in position usually being well up. The 2 central temporary incisors in each jaw are up.

The lateral temporary incisors pierce the gums soon after two months, and at three months old the pig has a fully-developed set of temporary teeth.

At nine months the corner permanent teeth are up, and the permanent tusks are through the gum, but one or two of the temporary tusks may be in position.

At one year old the central permanent incisors are cut, or the temporary incisors may be just still in their place.

The 5th molar is always through at a year, and just after a year the 3 anterior permanent molars are in the mouth.

At between seventeen and eighteen months the 6th permanent molar is cut, and the lateral temporary incisors are replaced by permanent teeth.

Dog.—Up to a certain point there are rough indications as to a dog's age.

The eyes of a pup are closed at birth, and remain so from ten days to two weeks. All the incisor teeth are usually present at birth, or may appear in a day or two.

In most dogs the full mouth of teeth is 42, 12 incisors, 4 canines, and 26 molars. In short-nosed dogs all the molars may not be present, or soon lost, but in long-nosed dogs also there is not always the full complement of molar teeth. At one year old the teeth are beautifully white, and there is a peculiar shape of the incisors like a trefoil, or representation of one of the three figures of the royal insignia of France, commonly called a *fleur de lis*. This *fleur de lis* has gone at two years old.

The canine teeth make their appearance in from four to six weeks, and are replaced by permanent ones at from five to six months.

Molars.—There are 12 molars in the upper jaw, and 14 in the lower.

The 1st permanent molar appears at about fourteen weeks.

The 2nd and 3rd temporary molars in the upper, and the 4th temporary molar in the lower, jaw are replaced by permanent ones at six months.

The 5th permanent molar is present at the fifth month, the 6th at the sixth month, and the 7th at the seventh month. The molars have acute lobes on their crowns, adapted for tearing flesh and not eating biscuits.

At two years the teeth show signs of wear. At five years they are blunt, and then or later on are covered with a brown deposit called tartar.

The mode of living, kind of food, and work or amusement done, exert their effect on the dog's teeth. A dog that fetches or carries stones or gnaws hard bones will soon blunt or break his teeth. Fighting may cause loss of the teeth.

[H. L.]

Age of Plants.—We here consider, first, the age to which plants may live; second, how long seeds may lie in the ground in a dormant state without losing their power of germinating.

1. Like ourselves plants live and die. The allotted span is sometimes fixed by nature at a single season, as is the case for corn and wheat; sometimes the limit is extended to two seasons, as for Swedes and Mangel. In sharp contrast to these short-lived plants there are true perennials, which, accidents debarred, may so to speak live for ever. The explanation of the short duration of life in an annual Oat or a biennial Swede is found to lie in the construction and very nature of the plant itself. There is, in these cases, no specially-prepared *bud* fit to continue the growth onward through the years, hence the early death. In a Mangel or Swede the two-year limit of life may be curtailed to one year if in its youth the plant has received a 'check' either from cold or drought. This means that there is no sharp boundary fixed by nature between annual and biennial plants. Art and selection are often necessary to give permanence to biennial character. At times it is easy to mistake a short-lived plant for a long-lived perennial. Red Clover, for example, is often found growing in an old pasture, and we are apt to call this 'perennial clover', forgetting that the hard seeds of the clover may pass undigested through the browsing animal and produce an ordinary short-lived plant.

Passing on to the long-lived perennials we find that these, in contrast to the short-lived species, have the power and habit of making a special provision of buds for continuing the growth, and by means of these buds they renew the youth of the plant, season after season; and not only that, but they keep a reserve supply of 'dormant buds' to meet the unforeseen and accidental. All have heard of Yew-trees with rings of wood in the trunk so numerous that they can scarce be counted. Each of these rings of wood means a year of life. Leaving these matters of history, all know in their own experience trees and shrubs which must have lived for very many years. Descending from the shrubs to the very herbs in our old pastures, we find there grasses that have been living from time immemorial. These old grasses are in reality young, for they have kept on renewing their youth by using up the stock of buds produced each year for that very purpose; they have turned these buds into new shoots and roots, and though the old parts have died away the plant is still the same, truly a perennial, lasting through the years and the seasons, and though old, ever retaining the characters of youth.

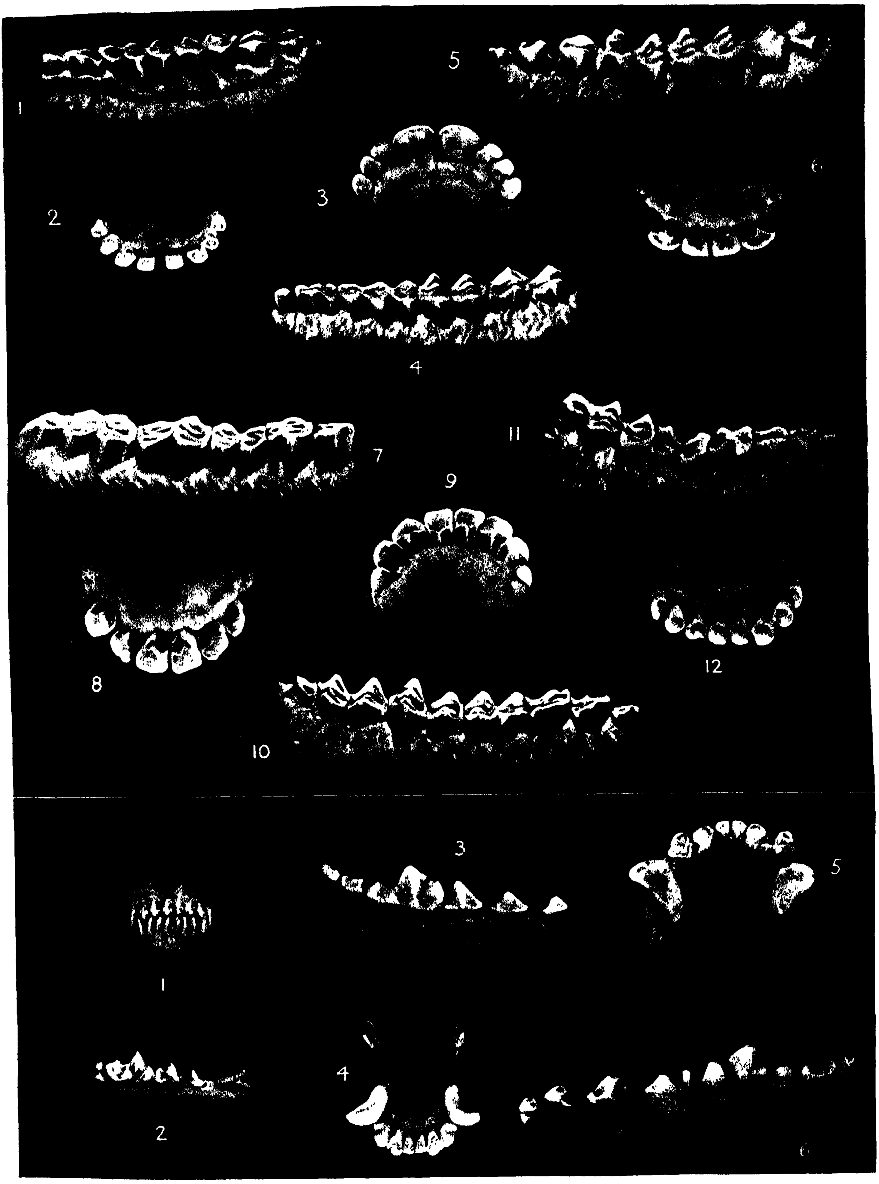
These peculiarities of long-lived plants may be turned to our advantage by art; by carelessness and want of foresight, to our detriment and loss. Even in spite of all care, the long-lived weed may be a source of perennial trouble.

When, for example, the art of the pruner is turned upon a hawthorn hedge, through the medium, it may be, of a labourer, the hawthorns are induced to utilize their supply of 'dormant buds': we force them to it by cutting off the tips of their branches, and, in this way, art makes a thin hedge thick and bushy. The same effect is produced on grass in pasture when the browsing stock nibble off the tips of the shoots; the 'dormant buds' are thereby induced to develop, thus forming bushy grass plants, and the whole sward is now thicker than before. A like effect is produced, though in another way, by means of 'rolling'.

On the same principle, the art of the pruner, when exercised on the roots of fruit-trees, induces the root not only to develop its 'dormant roots' but also to make new ones, thus securing that thick and bushy root system which favours fruit formation. Transplanting has the same effect, and works on exactly the same principle.

The art of utilizing the peculiarities of long-lived plants is further seen when we lay down a permanent pasture by means of grass and clover seeds. In such a case it is, above all, important that a sufficiency of seed from permanent plants be used to make a good sward by the third year. If not, we take the risk of having our land occupied by perennial plants of all sorts, not by those good grasses which one would choose. In such a case, we are content to take whatever accident

AGE OF ANIMALS--III

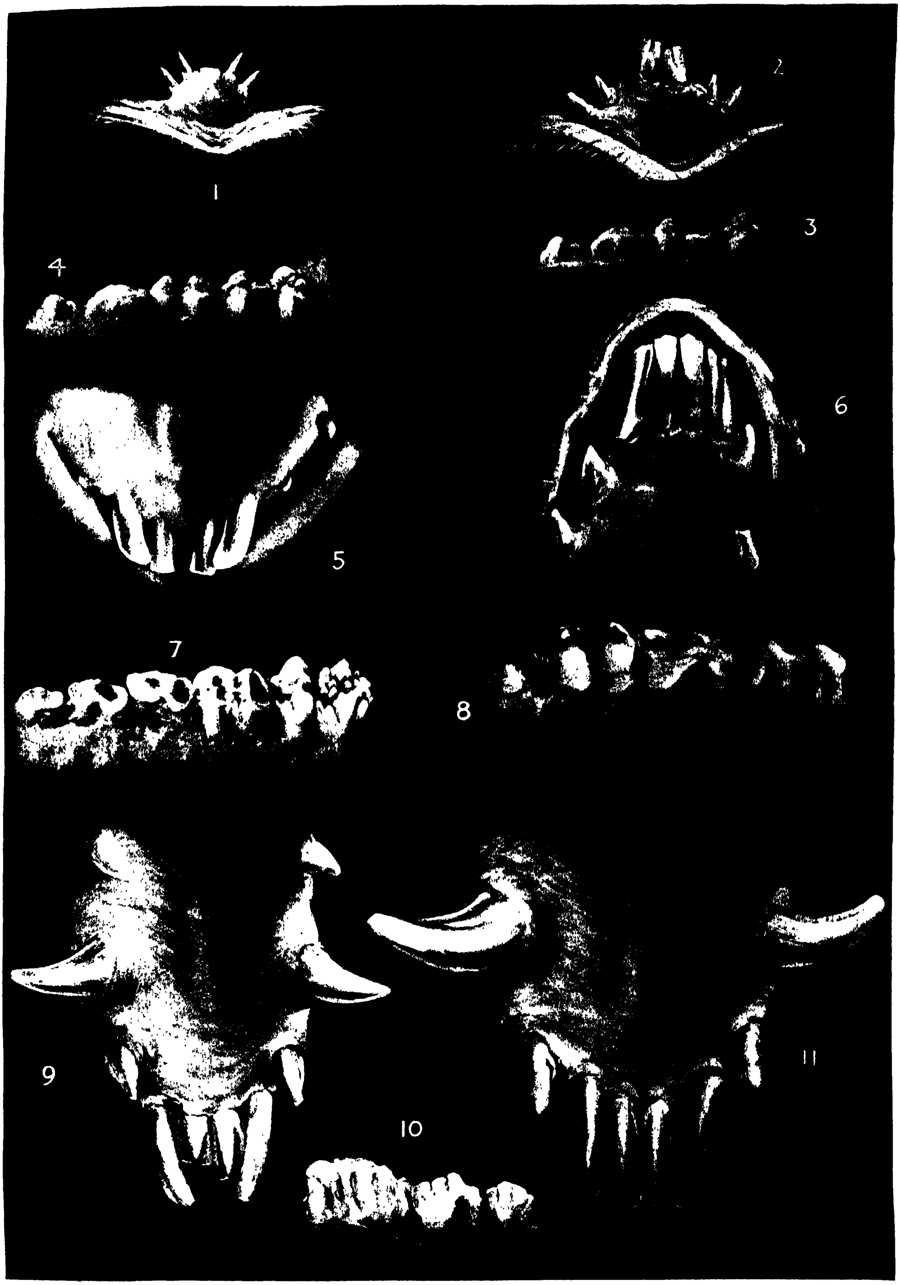


DENTITION OF SHEEP AND DOG

SHEEP. 1, Molars (fifth molar recently cut), and 2, Incisors, ninth to tenth month; 3, Incisors (first pair broad teeth well up), and 4, Molars, fifteenth month; 5, Molars (sixth molar well up), and 6, Incisors (second pair broad teeth cut), one year and ten months; 7, Molars (fairly uniform), and 8, Incisors (third pair permanent teeth cut), two years and three months; 9, Incisors (a full mouth: corner teeth recently cut), and 10, Molars, three years; 11, Molars, and 12, Incisors, four-and-a half years.

DOG 1, Incisors, and 2, Molars, Pomeranian Dog, three months; 3, Molars, and 4, Incisors, Terrier, nine to twelve months; 5, Incisors, and 6, Molars, aged Irish Terrier, twelve years.

AGE OF ANIMALS—IV



DENTITION OF THE PIG

1, At Birth ; 2, Incisors, one month ; 3, Three temporary molars, at three months ; 4, Molars at four-and-a half months (fourth molar to be seen partly covered by gum) ; 5, Incisors at three-and-a-half months ; 6, Incisors at nine months ; 8, Molars, ninth month (fifth molar just cutting) ; 7, Molars, one year (fifth molar well up) ; 9, Incisors, one year ; 10, Three anterior permanent molars cut, fifteenth month ; 11, Permanent incisors well up, twenty months.

may bring forth. There are grass plants whose nature it is to exhaust their stock of buds in a very few years; for such grasses as these, death must ensue whenever new buds are not forthcoming. Italian Rye Grass is a case in point. Its nature is to be very short-lived, to exhaust its bud-producing power in very few seasons; and thus Italian does not occur in old pastures. In laying down land to permanent pasture we must, again, be specially on guard against being misled by a name. 'Perennial' Rye Grass is a case in point here. The fact of the matter is that, except in special environments, Perennial Rye Grass is not perennial at all, for, as a rule, most of this Rye Grass has disappeared from the pasture by the third or fourth year, and this simply because it is the nature of the plant, under ordinary circumstances, to lose its power of bud-making after a few years.

But, for the agriculturist, the most interesting point in connection with long-lived plants is the heavy loss which they entail—loss of crop, and heavy increase of the labour bill for cleaning the land. It is the perennial plant which, above all, causes the everlasting expense of cleaning. If we go to arable land, of the light, sandy type, there we find growing and flourishing the Couch Grass or Twitch (see COUCH GRASS), the Pearl Grass (see ARRHENATHERUM), and the Bent Grass or Agrostis (see AGROSTIS VULGARIS)—all perennials of the most pronounced character. Now these light land weeds have this peculiarity: they all have the power of renewing their youth by means of arrangements which they keep in safety underground; indeed, quite a tiny morsel of this underground part suffices for propagation and renewal.

Take the case of Couch Grass. Here the propagating machinery is extended horizontally at a considerable depth all through the ground. Any attempt to pull out is necessarily vertical, and this vertical pull is to a large extent frustrated by the extended horizontal growth. Breakage rather than uprootal is the result. Every cut you make with a plough is merely making one into many, for each morsel of the plant has its bud or buds for continuing the growth, and thus bad is made worse. It is not difficult then to understand how the light-land farmer has Couch always with him, how he is always removing it and yet it is never removed.

Take, again, the case of Pearl Grass. Here, unlike Couch, the underground propagating machinery is not spread horizontally, but is all compacted into a bunch. The bunch is composed of many chains of buds, and each individual bud is furnished for itself with a special store of nutriment, to give a new and successful start whenever opportunity offers. Each one of these buds with its swollen store of nutriment is the 'pearl', a certain omen of trouble in store for the light-land farmer, unless he takes very good care not only to remove it from his land, but to kill it after removal.

Of all the troubles which the never-ending life of weed plants entails upon the farmer, the most potent source is Bent Grass or Agrostis (*Agrostis vulgaris*). The farmer has this pest in his arable land, in his pasture land; light land, heavy land, rich land, poor land, nothing comes amiss to Agrostis. This ubiquity is easily understood when we consider the peculiar way in which Agrostis stools out and takes possession of the land. Unlike Couch, its horizontal shoots suit their depth to environment; if there is drought the shoots run in the depths, if there is surface moisture the shoots run along the surface. This plasticity is quite beyond the power of Couch, which is therefore by comparison confined and local. This cosmopolitan character of Agrostis is well expressed by the popular name Bent, which means a common or uninclosed tract, and indicates ubiquity.

In pastures which have been seeded with Perennial Rye Grass the evils resulting from the longevity of Agrostis are most marked. There, by the third or fourth year, the non-perennial Rye Grass has to a large extent died away, and 'natural grass' has come instead. What is this 'natural grass'? Often it is naught else but the eternal Agrostis. The explanation is very simple. Bits of Agrostis were lying in the land, and each of these bits has developed its bud into an Agrostis plant with a practically endless lease of life. It is not the seed of Agrostis which has produced this 'natural grass', but merely bits of old Agrostis which have renewed their youth. Of this we are sure: if there had been no Agrostis in the land to start with, none could ever have come out. We must not think of this Agrostis as having no redeeming feature; stock browse it, and on land well treated thrive on it. What we do object to is the presence of Agrostis on land where choicer grasses might be flourishing to more profit.

2. Not only does loss come to the farmer from the longevity of seed plants, but also from the fact that in practice he has to deal with aged seed which may have lain in his land for years or even for whole generations. The evil is that these old seeds in the land may pass from the dormant state into active life, and produce either short-lived plants, or it may be plants of a most pronounced perennial type which take the farmer by surprise. It is of comparatively little importance to consider the result which may come from the purchase and sowing of 'antique' seed, because any loss from this is quite easily prevented by having the germinating power tested or guaranteed before sowing. It is quite otherwise when we consider that the seeds of weeds may be lying in the land and suddenly come forth as weed plants, to the great detriment of our crop. This matter is certainly worth careful consideration. There are cases where seed cannot lie dormant in the land, where awakening to active life must be immediate or not at all. Such, for example, is Elm seed: if germination is not immediate the power is gone for ever.

In other cases the seed requires, or at least is none the worse of, a short period of rest. Such are most of our agricultural seeds. These retain their powers fairly well, if kept in a dry and airy place, for an extra year or so.

But, as we have said, those seeds which can lie long in the land without loss of power are of most immediate interest to the agriculturist. All such seeds have some structural peculiarity which accounts more or less for their special gift of lying dormant for years. There is always a something about these seeds which can specially control and limit the entrance of moisture to an extent sufficient to prevent the germination process from starting and going on. Without this moisture the change from dormant to active life cannot take place. In the case of clovers, for example, some, not all of the seeds, have a specially hard, thick, waterproof skin. These hard seeds are easily recognized by boiling; unlike the others the 'hards' remain quite unsoftened, like a bit of flint. Doubtless these 'hard seeds' can lie dormant in the ground and come up as clover plants in after-years. Also these 'hard seeds' can pass undigested and intact through the alimentary canal of an animal. Thus it happens that an application of dung, however 'clean', may be equivalent to a sowing of white or red clover, and thus it happens also that red clover or white clover may spring up in connection with a dropping from a beast.

Again, in the case of Runch (see RUNCH), each and every seed that the plant bears is enclosed in a special case or seed box, and it is easy to understand how seeds so encased may lie in the land not only for one rotation of crops but for whole generations of men. Cases are on record of grass land which had not been under the plough within the memory of man, and yet, on being broken up, a good crop of Runch weeds was obtained with the lea oats. In clovers only the 'hard seeds' are capable of remaining dormant, whereas in Runch every seed is dormant by nature. Runch, again, differs from the Mustard weed Charlock (see CHARLOCK) by keeping its seeds boxed in, whereas Charlock lets every seed go free from the pod, and it is this encasement which gives the air of mystery to Runch as compared with the simple Charlock.

Among the cereals Wild Oat or Shetland Oat is worth mention, because forgetfulness of the fact that the seeds of this oat can lie dormant in the land has led to much confusion and error. Our forefathers used Wild Oat as a seed corn, and this taken in conjunction with the power of lying dormant helps to explain away a very common idea that cultivated oats can 'revert' to the wild state. The so-called 'reversion' may well be due to the fact that seasonal peculiarities favoured the Wild Oat at the expense of the cultivated sort.

The same kind of explanation easily applies to the change or 'reversion' of cultivated corn into Goose Corn or Goose Grass (*Bromus mollis* and *secalinus*), to mysterious cases of 'reversion' of Perennial Rye Grass into Hard Fescue or into Crested Dogstail, or even into Yorkshire Fog (*Holcus lanatus*); and so forth. Before such cases of 'reversion' can be considered genuine, we must take precautions to assure ourselves that no seeds other than those said to 'revert' could by any possibility be present.

The famous tales of seeds of wheat found in mummy coffins retaining till the present day their vitality cannot be seriously credited; there is here too much inducement and opportunity for trickery and fraud. Judging from the descriptions of the plants yielded by 'mummy wheat' grains, it cannot be said that they produce a variety unknown to us; what they do produce is a 'sportive' sort of wheat quite well known to all interested in such varieties.

We cannot leave the subject of dormant seeds without noting the case of Mangel. What is called in commerce 'Mangel seed' is not true seed at all, but three seeds enclosed in a hard case. This explains some points of difficulty—how the germinating power may reach 300 per cent!, and how special treatment of the seed is necessary to secure speedy germination.

It would be well for us if it were only the seeds of weed plants that could thus lie dormant in the soil. The unfortunate thing is that the spores of certain fungi which cause prevalent diseases in our crops play the very same trick upon us; witness the spores of that fungus which causes finger-and-toe in turnips. Here, the minute spores are enclosed each in a thick-walled box, and in this protected state the spores can lie in the soil for years waiting for our turnip crop. We must make our course of rotation specially long would we wait until the dormant state of these spores becomes the rigid state of death.

If we now pass in review the points connected with the age of plants, we notice that longevity and permanence is not an unmixed blessing, for in our pastures this very permanence leads not only to the very best grasses we know, but also to the production of the very worst and most troublesome weeds. In our arable fields it is this same permanence which leads to the necessity of the most thorough cleaning, and which forces us to completely kill the removed parts of the weeds by burning or by compost. We dare not pollute our dung even with scraps of these permanent weeds, so extraordinary is their power of regaining youthful vigour.

As for the power which old seed has of lying dormant, that is also a troublesome matter which often puts us to confusion. In our pastures it leads up to such bad grasses as Yorkshire Fog, in our arable fields to a whole host of troubles—Goose Grass, Runch, finger-and-toe disease, and so forth. How careful must we then be about little things would we bring large concerns to a successful issue. [A. N. M'A.]

Agrarian.—This term first comes under our notice as the epithet of a Roman law for the division of conquered lands (*Lex agraria*). From that particular sense it has come to be applied generally in qualification of anything pertaining to laws or customs or political agitation in connection with the ownership or tenure of land. Thus 'an agrarian outrage' signifies an act of violence originating in discord between landlords and tenants.

In a purely botanical sense this term was applied by Watson to denote the lowest of the altitudinal zones into which he proposed to classify vegetation. The agrarian zone included all within the limits of the cultivation of corn.

[J. B.]

Agricultural Banks. See BANKS.

Agricultural Botany. See BOTANY.

Agricultural Education. See EDUCATION.

Agricultural Engineering. See ENGINEERING.

Agricultural Holdings (England) Acts, The. — The Agricultural Holdings (England) Act, 1883, the Tenants' Compensation Act, 1890, the Market Gardeners' Compensation Act, 1895, the Agricultural Holdings Act, 1900, and the Agricultural Holdings Act, 1906 (called until it reached its later stages in Parliament 'the Land Tenure Bill') have been consolidated by the Agricultural Holdings Act, 1908 (8 Edw. VII, c. 28), so as to form one code of law affecting the relations of landlords and tenants of agricultural land in England and Wales, which came into operation on 1st Jan., 1909.

The chief purpose of this Act is to secure to the tenant, on the determination of his tenancy, compensation for improvements which he may have made on the land in his occupation, but it contains also certain other alterations in the former law of landlord and tenant. The Acts of 1883 and 1895, which applied to England only, were mainly the same as the Agricultural Holdings (Scotland) Act, 1883, and the Market Gardeners' Compensation (Scotland) Act, 1897, respectively, and the Acts of 1900 and 1906 applied alike to both countries. The enactments affecting Scotland are consolidated by the Agricultural Holdings (Scotland) Act, 1908.

APPLICATION OF THE ACT.—The Act applies to any 'holding', either 'wholly agricultural or wholly pastoral, or in part agricultural, and as to the residue pastoral, or in whole or in part cultivated as a market garden', but not to any holding which is let to the tenant during his continuance in any office, appointment, or employment held under the landlord (s. 48). A 'holding' is any parcel of land held by a tenant of the description above mentioned (s. 48). It would seem, then, that the tenant of any parcel of land which is of the character above mentioned is entitled to the advantages of the Act, and it does not signify that other property not agricultural or pastoral, *e.g.* a dwelling-house and garden, or woodland, may be included in the same letting. It is only, however, when the tenant quits his holding at the determination of his tenancy that he becomes entitled to compensation (s. 1); but he does not lose his right when he quits, by reason only that the improvements on account of which he claims were actually made during a former tenancy and not during the tenancy at the determination of which he is quitting, for the tenant loses no right to compensation which he has already acquired, by entering into a fresh contract of tenancy or by taking a fresh lease from his landlord (s. 8). Further, if an incoming tenant, with his landlord's consent in writing, has paid to an outgoing tenant compensation under the Act in respect of the whole or part of any improvement, he is entitled on quitting his holding to claim compensation in respect of the improvement in like manner as the outgoing tenant would have been entitled had he remained tenant and quitted the holding at the time when the incoming tenant quits (s. 7).

THE RIGHT TO COMPENSATION.—The Act provides that the tenant is to be entitled at the determination of the tenancy, on quitting his holding, to obtain from the landlord, as compensation for an improvement, such sum as fairly represents the value of the improvement to an incoming tenant (s. 1, sub-s. 1). The measure of compensation is thus the value to an incoming tenant; and this it is that an arbitrator, before making an award under the Acts, is bound to ascertain to the best of his ability, and not merely what the improvement may have cost to execute. The person to pay the compensation is primarily the landlord, though it is sometimes arranged that the incoming tenant shall take the burden upon him. The landlord is defined as meaning 'any person for the time being entitled to receive the rents and profits of any land', which would include a trustee or mortgagee in possession (s. 48); and under s. 12, a mortgagee depriving a tenant of the occupation of land, in the case of a tenancy not binding on the mortgagee, must compensate the occupier for his crops, improvements, and tillages, and for any expenditure upon the land made by the tenant in the expectation of remaining in the holding for the full term of his contract of tenancy, so far as any improvement is not then exhausted.

The right of the tenant to compensation cannot be defeated by any contract (whether under seal or not), for agreements inconsistent with the Act in this respect are declared void (s. 5); but in respect of improvements mentioned in the third part of the First Schedule to the Act (see succeeding article, p. 66), if any agreement secures to the tenant 'fair and reasonable' compensation, having regard to the circumstances existing at the time of making the agreement, compensation will be payable in pursuance of the agreement, and is declared to be substituted for compensation under the Act (s. 4). And if the tenant prefers to do so, he may claim compensation for any improvement under custom, agreement, or otherwise, instead of making a claim under the Act (s. 1, sub-s. 3).

The compensation due to a tenant will be diminished (*a*) by any benefit given or allowed to him by his landlord in consideration of his executing the improvement; (*b*) by an allowance for the value of the manure required by the contract of tenancy or custom to be returned to the holding in respect of any crops sold off or removed within the last two years of the tenancy, not exceeding the value of the manure which would in fact have been produced by the consumption on the holding of the crops so sold off or removed (s. 1, sub-s. 2). No claim can be made by a tenant for compensation for any improvements other than 'manuring', as defined by the Act (items 23, 24, and 25 in Schedule I, Part iii; see succeeding article, p. 66), begun within a year before he quits the holding, or at any time after the final notice to quit, unless the landlord, after notice served of the tenant's intention to begin the improvement, has assented or failed for a month after receipt of the notice to object to the making of the improvement (s. 9).

THE SUBJECT-MATTER OF THE CLAIM.—The

matters in respect of which a claim for compensation may be made under the Agricultural Holdings Act, 1908, are stated in the First Schedule to the Act, which is hereafter set out (see succeeding article, pp. 65, 66). In respect of improvements mentioned in Part I, the written consent of the landlord is required to enable a tenant to obtain compensation, and the consent may be given unconditionally, or upon terms as to compensation or otherwise. The consent may be in general terms by the lease under which the tenant holds, as in the case of Mears *v.* Callender (1901, 2, Ch. 388), where a permission in the lease to convert meadow land into orchard was held to be a consent by the landlord which gave the tenant a right to compensation at the end of his tenancy for orchard trees planted by him. In respect of drainage, which is the only improvement included in Part II of the First Schedule, no consent by the landlord is required; but the tenant, not more than three months or less than two months before beginning to execute the improvement, must give notice in writing to the landlord of his intention to execute the improvement, and of the manner in which he proposes to do the intended work, and thereupon the landlord may, if he pleases, undertake to execute the improvement himself, and charge the tenant with a sum not exceeding 5 per cent on his outlay, or not exceeding such annual sum payable for twenty-five years as will repay the outlay by instalments, with interest at 3 per cent. In default of any agreement as to the terms of compensation, or if the landlord fails to execute the improvement within a reasonable time, the tenant may execute the improvement himself, and will be entitled to compensation on the determination of the tenancy. The improvements mentioned in Part III of the First Schedule are mainly improvements which tend to increase the fertility of the soil by the application thereto of some external substance, such as manure, lime, clay, &c. Compensation may be claimed in respect of these improvements, though made without the consent of the landlord. As from the 1st Jan., 1909, there has been added to Part III of the Schedule repairs to buildings necessary for the proper cultivation or working of the holding other than repairs which the tenant is himself under an obligation to execute; but in this case, before executing the repairs the tenant must give notice in writing to the landlord of his intention, with particulars, and he is not to execute the repairs unless the landlord fails to execute them within a reasonable time after receiving such notice.

It may be mentioned here that in the English courts, so far as the writer is aware, no claim has ever been allowed for 'cumulative fertility' (see succeeding article, p. 67), which is not one of the matters specifically mentioned in the Schedule as giving a right to compensation, and which could not, according to any recognized canon of interpretation, be read into the Acts. The Acts give rights to compensation for fertility caused by the application by the tenant of manures or the consumption of feedingstuffs during the tenancy; but 'cumulative fertility' is, it would seem, of too vague and uncertain character to give a right to compensation at the landlord's expense.

THE MAKING OF THE CLAIM.—There is no provision as to the making of the claim except that it shall not be made after the determination of the tenancy, or in case of an improvement executed after the determination of the tenancy in part of the holding of which the tenant lawfully remains in occupation before quitting that part. Under the Act of 1883, 'the determination of the tenancy' was in Morley *v.* Carter (1898, 1 Q. B. 8) held to be its determination as an agricultural tenancy, although the buildings might be retained till a later date.

The claim need not be formulated in writing, or contain particulars of the amounts claimed, and it may apparently be amended after delivery. It will, however, usually be advisable to make it in writing, and with some general particulars of the amount and grounds of claim.

THE ARBITRATION.—If the landlord and tenant fail to agree as to the amount, time, and mode of payment of compensation, the matter must be referred to arbitration in accordance with the provisions set out in the Second Schedule to the Act of 1908, which forms a code intended to regulate the settlement of all differences arising between landlord and tenant. Previous to 1st Jan., 1909, any arbitration was decided by a single arbitrator unless the parties otherwise agreed; but after the 1st Jan., 1909, all questions referred to arbitration under any part of the Act, or under the contract of tenancy, must, notwithstanding any agreement to the contrary, be determined by a single arbitrator. The arbitration may, in addition to dealing with claims for compensation under the Acts, be made to extend to any sum due to the tenant from the landlord in respect of breach of contract or otherwise in respect of the holding, so as to include claims for tillage, unconsumed hay and straw, &c. It may also extend to claims by the landlord against the tenant for waste or breach of contract. If it is desired that it should extend to these additional matters, written notice must be given by the claiming party to the other, by registered letter or otherwise, not later than seven days after the appointment of the arbitrator.

The arbitrator will be a person agreed upon between the parties, or in default of agreement nominated by the Board of Agriculture and Fisheries. He must make and sign his award within twenty-eight days after his appointment, unless the time is extended by the Board of Agriculture and Fisheries. He has power to take evidence on oath, and may at any stage of the proceedings, and shall, if so directed by the judge of a county court, state in the form of a special case any question of law arising in the course of the arbitration. The opinion of the county court on the question so stated will be final, unless within the time prescribed (twenty-one days) either party appeals to the Court of Appeal, from whose decision no appeal will lie. The arbitrator's award must be in the form prescribed by the Board of Agriculture and Fisheries, and is final and binding on the parties and the persons claiming under them respectively. It must fix a day, not sooner than one month nor later than two months after the delivery of the award, for the payment of the money awarded for compensation, costs, and otherwise. The costs of and incidental to this arbitration and award are, in the discretion of the arbitrator, subject to taxation by the registrar of the county court, and in awarding costs the arbitrator must take into consideration the reasonableness or unreasonableness of the claim of either party, and generally all the circumstances of the case (A. H. Act, 1908, Schedule II.)

The parties to the arbitration and all persons claiming through them respectively must, subject to any legal objection, submit to be examined by the arbitrator on oath or affirmation in relation to the matters in dispute, and must (subject as aforesaid) produce before the arbitrator all samples, books, deeds, papers, accounts, writings, and documents within their possession or power respectively which may be required or called for, and do all other things which during the proceedings the arbitrator may require. The arbitrator must, on the application of either party, specify the amount awarded in respect of any particular improvement or any particular matter the subject of the award. Notwithstanding the provision for the appointment of a single arbitrator to determine all differences between landlord and tenant, the mode of procedure under the Act need not differ greatly from what it has been in the past. Each party will probably find it convenient to appoint a valuer to act on his behalf, as before the Act; and if on going into the various claims on either side the two valuers, being properly authorized by their principals, mutually agree as to the figures, the principals will be bound, and no arbitration will be necessary. If the valuers cannot agree in their valuations the matter will be referred to the arbitrator, before whom the valuers will be competent witnesses. They will not, as has been commonly the case in arbitrations under the Agricultural Holdings (England) Acts, 1883 to 1900, sit as assessors to the umpire.

Money agreed or awarded to be paid for compensation, costs, or otherwise, if not paid within fourteen days after the time when it is agreed or awarded to be paid, is recoverable upon order made by a county court judge as money ordered by a county court under its ordinary jurisdiction to be paid is recoverable (A. H. Act, 1908, s. 14).

CHARGE OF TENANT'S COMPENSATION.—A landlord, on paying to a tenant the amount due to him in respect of compensation under the Acts, may obtain from the Board of Agriculture a charge on the holding for the amount so paid (A. H. Act, 1908, s. 15), and this right extends to a landlord's executors paying compensation to an outgoing tenant whose tenancy determined before the landlord's death (Gough *v.* Gough, 1891, 2 Q. B. 665). This provision also enables a landlord who is a tenant for life of the land, or whose estate is otherwise limited, to charge money expended in paying compensation for the benefit of those interested in his personal estate.

Provision is also made that compensation payable to a tenant from a landlord who is a trustee shall not be recoverable against him personally, but will be charged on the holding (s. 35).

PENAL RENTS.—Penal or additional rents for breach of the tenant's covenants were formerly frequently inserted in farm leases and tenancy agreements with the view of deterring tenants from such breaches. By section 25 of the Agricultural Holdings Act, 1908, a landlord will not, under a provision for payment of a penal or higher rent for breach of a covenant or condition, be entitled to recover any sum in excess of the damage actually suffered by the breach or non-fulfilment of the covenant or condition. It is, however, provided that this section is not to apply to any covenant or condition against breaking up permanent pasture, grubbing underwoods, or felling, cutting, lopping, or injuring trees, or regulating the burning of heather.

FREEDOM OF CROPPING AND SALE OF PRODUCE.—From 1st Jan., 1909, the date when the Agricultural Holdings Act, 1908, came into operation, tenants are given, notwithstanding any custom of the country or provision to the contrary, the rights of freedom of cropping arable land, and of sale of produce of any land in their occupation. The exact terms of the portion of the section giving these rights will be found in the succeeding article, p. 70. The rights so given are not exercisable in the last year of the tenancy, as regards which any covenants as to cropping will still be enforceable. If the rights conferred by the section are exercised so as to injure or deteriorate the holding, the landlord may recover damages from the tenant for injury or deterioration, or obtain an injunction to restrain threatened injury. It will be noted that the freedom of cropping only applies to *arable* land, so that grass lands may still be protected by agreement from excessive mowing or deterioration in other ways. The provisions against injury or deterioration only apply when 'the tenant exercises his rights under this section'; so that, in order that the land may be protected against bad farming, it will still be necessary to include in the lease or tenancy-agreement express stipulations as to the proper mode of cropping, &c.; otherwise if the tenant is left quite at large, unfettered by agreement or custom, he will not in any course he may pursue be exercising his rights under the section, and the remedies against injury or deterioration of the land will not be available.

COMPENSATION FOR DISTURBANCE.—The Agricultural Holdings Act, 1908, by section 11, gives a tenant a limited right to compensation for the termination of his tenancy or the refusal to renew his lease, if the termination or refusal is 'without good and sufficient cause, and for reasons inconsistent with good estate management' (see next article). It is difficult to say what would be considered by a legal tribunal to be 'inconsistent with good estate management'; but it is suggested that anything tending towards the more economical or profitable carrying on of the property—as by subdivision into smaller holdings, the amalgamation of farms, the development of building, or the planting of woodland—would come under the phrase 'good estate management', and so exclude the right to compensation, although the termination of the tenancy might press hardly on the individual tenant dispossessed.

A demand for an increase of rent, which results in a tenant quitting, only appears to give a right to compensation if the increase is demanded by reason of an increase in the value of the holding, resulting from improvements executed by or at the cost of the tenant. An increase demanded on account of the natural rise in value of the land would seem to be no ground for compensation.

Notice of intention to claim compensation for disturbance must be given, in writing, to the landlord within two months after the notice to quit, or refusal to renew the tenancy, and the amount payable will, in case of difference, be determined by arbitration.

Record of the Holding.—A record of the condition of the holding may be required at the commencement of any tenancy by either party under section 27 of the Agricultural Holdings Act, 1908 (see succeeding article, p. 70). The expense of making such a record is in default of agreement thrown on the landlord and tenant in equal proportions.

Other Matters dealt with by the Acts.—The Agricultural Holdings Act also affects the relations of landlord and tenant of agricultural land in respect of notice to quit, fixtures, resumption for improvements, rights of distress, market gardens, and compensation for damage by game. These matters will respectively be dealt with under the appropriate headings in later portions of this work. See further the succeeding article on the Agricultural Holdings (Scotland) Act, 1908. [A. J. S.]

Agricultural Holdings Acts, The (Scotland, 1883–1900, and Britain, 1906).—Previous to the passing of the Agricultural Holdings Acts, the tenants of farms were under decided disadvantages in respect of unexhausted improvements made by them on their farms. On removal from them, they had no valid claim for compensation for the improvements they had executed, the presumption of the law being that these were the property of the landowner unless an express stipulation to the contrary had been made in the terms of the tenancy. In such circumstances some tenants holding under lease were tempted to manage their farms liberally during the earlier years of the lease, and to impoverish them to a greater or lesser extent towards its close. Lessees who had not yielded to this temptation, but had kept their farms in high manurial condition, at the close of the tenancy were exposed to the hardship of having their rents raised on the improvements which they themselves had effected. By the passing of the Agricultural Holdings Acts, the presumption of the law was changed. The tenant on his removal from the holding is entitled to obtain from the landlord as compensation such sum as fairly represents the value of the improvement to the incoming tenant. Thus, in negotiating with a tenant for a renewed lease, the landlord is confronted with the consideration that if there is a change in the tenancy he is liable in compensation to the outgoing tenant. One of the objects kept in view in passing the statutes was to steadily maintain the farm in a high state of fertility in the interests of the nation. The alternate feeding and exhaustion of the soil was a state of matters far from desirable, especially in a country which is largely dependent for the food of the people on imported produce.

The principal Act was passed in the year 1883, and amending Acts received the royal assent in 1900 and 1906. The last-mentioned statute came into operation on the 1st of January, 1909.

This paper is likely to prove of the greatest practical value to those concerned, if the many points involved are dealt with in the order in which a tenant leaving a farm must take the successive steps necessary in making and presenting a claim for compensation.

Who is entitled to Compensation?—Where a tenant has made on his holding any improvement comprised in the First Schedule to the (1900) Act, he shall, subject to the Agricultural Holdings (Scotland) Act of 1883, and to the Act 1900, be entitled at the determination of a tenancy, on quitting his holding, to obtain from the landlord, as compensation under the said Acts for the improvement, such sum as fairly represents the value of the improvement to an incoming tenant.

The person who is popularly spoken of as ‘the sitting tenant’, that is, who has entered on a new lease, and remains in the occupancy of the holding, is not entitled to claim compensation. That right is only acquired when the tenant removes from it. However, by section 39, Act 1883, his right to compensation for improvements executed by him during one lease is carried forward under the new tenancy. To the sitting tenant the Act recognizes no loss of right other than the exhaustion of the improvement. It is only against the landlord that an outgoing tenant is entitled to make a claim; but some landlords have sought to saddle the incoming tenant with the responsibility of paying it, which is a course of doubtful expediency, for this, among other reasons, that when the new tenant enters into his lease he is not in a position to know what the extent of the claim may be. However, section 37 of the Act of 1883 provides that where the incoming tenant has with the consent of his landlord paid to an outgoing tenant any compensation under the statute in respect of the whole or part of any improvement, he can claim compensation for it when he quits the holding.

In the Act of 1883 a ‘holding’ is defined as ‘any piece of land held by a tenant’, and it is further declared that it may be ‘either wholly agricultural or wholly pastoral, or in part agricultural and as to the residue pastoral’. The question arises whether all land let along with a house or building comes under the operation of the statute. The true test in such cases seems to be whether the buildings are an appendage to the lands or the lands an appendage to the buildings. Under the former circumstances the claim to compensation is a good one.

From the definition given in the statute of a landlord, it is held that a sub-tenant is entitled to claim compensation from the principal tenant. A renunciation of his lease by the tenant, accepted by the landlord, does not bar the tenant's claim to compensation. A tenant removed for non-payment of rent 'shall have the rights of an outgoing tenant to what he would have been entitled if his lease had naturally expired' (1883, s. 27). An employee of a landlord who holds land during his continuance in any office, appointment, or employment of the landlord does not come under the Act (1883, s. 35).

WHEN MUST A CLAIM BE MADE?—Under the Act of 1883 a claim was not valid unless it was made not less than four months before the termination of the tenancy. One of the changes made by the Act of 1900 was that a valid claim can be made any time before the determination of the tenancy. In other words, so long as the tenant has legal possession of any part of the holding he can make a claim, which must be lodged either with the landlord or with his recognized agent or factor. Where he leaves the whole of the holding at a specified date or term, the interpretation of this provision is sufficiently plain. But it is not an unusual arrangement for a tenant to remove from the house and certain portions of the land, say, at Whitsunday or Martinmas, and from the remainder of it at the separation of the crop from the land. This being an indefinite and variable date, the question arose what it legally means. In the case of Black *v.* Clay, the House of Lords decided that where the removal was at Whitsunday as to the houses, grass, and fallow, and at the separation of the crop as to the remainder, the determination of the tenancy must be held to be the Martinmas following.

There is no prescribed method of lodging the claim with the landlord or his recognized agent, but probably the safest and most convenient way is to send it in the form of a registered letter. In cases where an agreement has been entered into between the owner and the tenant, providing for compensation in substitution of that prescribed in the Acts, it is not necessary to lodge a formal claim. However, where, as sometimes happens, there is an intention to call in question the legality of the agreement made, a claim should be lodged in the usual way. Where the outgoing tenant is to demand compensation for other improvements in addition to those included in the private agreement, a claim for them must be lodged. As explained under the statement dealing with the arbitrator's procedure, if the outgoing tenant wishes any unsettled claim against the landlord 'in respect of any breach of contract or otherwise in respect of the holding', he can, by taking the prescribed steps, bring the settlement of such additional claim within the arbitration proceedings.

PARTICULARS REQUIRED IN A CLAIM.—Under the Act of 1883, the tenant was required, in giving notice of a claim, to state, as far as reasonably might be, the particulars and amounts of the intended claim. The section requiring this has been repealed, and in the later statutes no rule is laid down as to the particulars which must be stated in the claim to make it valid. However, it stands to reason that the amount of the claim should be stated, along with such particulars as are necessary to enable the landlord to form a judgment of it on its merits. It is only in the event of the landlord and tenant failing to agree as to the amount and time and mode of payment of such compensation that the difference shall be settled by arbitration (1900, section 2, (1); and to make negotiations between the parties possible, the landlord must know the amount claimed and the particulars of each improvement for which the claim is made, including the year in which it was executed.

WHAT IMPROVEMENTS CAN BE CLAIMED FOR?—The improvements for which an outgoing tenant can validly claim compensation are confined to those specified in the Acts. He may have improved a farm in other ways, but for these he has no statutory or legal claim, unless this has been provided for in a private agreement. The improvements for which a claim can be made are specified in the three Parts of the First Schedule appended to the Act of 1900, and also in respect of repairs to buildings in section 6 of the Act of 1906. The conditions attached to each Part are not the same, and therefore we shall deal with each Part separately.

FIRST SCHEDULE.—Part I.

Improvements to which the Consent of the Landlord is required.

(1) Erection, alteration, or enlargement of buildings.
(2) Formation of silos.
(3) Laying down of permanent pastures.
(4) Making and planting of osier beds.
(5) Making of water meadows or works of irrigation.
(6) Making of gardens.
(7) Making or improving of roads or bridges.
(8) Making or improving of watercourses, ponds, wells, or reservoirs, or of works for the application of water power or for supply of water for agricultural or domestic purposes.
(9) Making or removal of permanent fences.
(10) Planting of hops.
(11) Planting an orchard or fruit trees.
(12) Protecting young fruit trees.
(13) Reclaiming of waste land.
(14) Warping or weiring of land.
(15) Embankments and sluices against floods.
(16) The erection of wirework in hop gardens.

By section 3, Act of 1883, the consent in writing of 'the agent of the landlord duly authorized on that behalf' is recognized as of equal authority with that of the landlord. However, it should be noted that the agent must be 'duly authorized on that behalf'. The consent of the landlord or his authorized agent 'may be given unconditionally or upon such terms as to compensation or otherwise as may be agreed upon between the landlord and the tenant; and in the event of any agreement being made between the landlord and the tenant, the compensation payable thereunder shall be deemed to be substituted for compensation under the Act'.

However, if specific compensation is not provided for under an agreement made between the landlord and the tenant, the amount to be paid by the former to the latter will fall to be determined by arbitration as laid down in the statutes. As regards the repairing of buildings which a tenant can execute and claim compensation for, see remarks under Part III.

First Schedule.—Part II.

Improvements in respect of which Notice to Landlord is required.

(17) *Drainage.*—The outstanding difference between the conditions attached to the three separate Parts of the First Schedule is as follows:—The *consent* of the landlord or his agent must be given to the execution of the improvements comprised in Part I. Under Part II *notice* must be given by the tenant to the landlord or his agent to entitle the former to obtain compensation for drainage executed by him, and under Part III (including repairs on buildings dealt with under section 6 of the Act of 1906) the tenant can make the improvements without either such consent or notice.

As provided for in section 4 of the Act of 1883, if a tenant wishes any part of his holding drained, under the provisions of the Act he must, not more than three months and not less than two months before beginning to execute that improvement, give notice in writing to the landlord or his agent of his intention to drain the land. The notice, which must state the manner in which he proposes to do the intended work, must not be given too soon or too late, but as is specified above. Either of two alternatives may subsequently be followed. Either the landlord or tenant may make an agreement regarding the terms, as to compensation or otherwise, on which the improvement is to be executed; and in the event of an agreement being made that the improvement is to be executed by the tenant, the compensation payable under such agreement shall be deemed to be substituted to compensation under the Act. The other alternative is that the landlord may elect to undertake to execute the improvement himself; and, unless the notice is previously withdrawn, he may proceed to do so in any reasonable and proper manner which he thinks fit, and charge the tenant not more than 5 per cent per annum on the outlay incurred in executing the drainage, or not exceeding such annual sum payable for a period of twenty-five years as will repay such outlay in the said period with interest at the rate of 3 per cent per annum, such annual sums to be recoverable as rent. In the event of no agreement being come to, and also where the landlord fails to carry out his undertaking, a tenant may execute the improvement himself and be entitled to compensation under the arbitration provisions of the Acts. It would seem that the tenant can withdraw the notice at any time before the landlord begins operations. The landlord is not bound to drain the land in the manner proposed by the tenant, but he is precluded from draining a greater area than is specified in the notice given by the tenant.

The kinds of drainage to be executed are not defined or described in the statute. Mere repairs on existing drains are not included. Of course, tile draining is included, but the question has been raised whether open drains, popularly spoken of in connection with pastoral lands as 'sheep drains', are embraced in the term drainage. It seems to us that these are undoubtedly included. The statutes apply to holdings which are 'either wholly agricultural or wholly pastoral, or in part agricultural and as to the residue pastoral'. What are termed 'open' or 'sheep drains' are comparatively as valuable an improvement to the one class of holdings as tile drains are to the other, seeing that drainage consists in the drawing-off of water by any channel either open or covered.

First Schedule.—Part III.

Improvements in respect of which Consent of or Notice to the Landlord is not required.

(18) Chalking of land.
(19) Clay-burning.
(20) Claying of land or spreading blaes upon land.
(21) Liming of land.
(22) Marling of land.
(23) Application to land of purchased artificial or other purchased manure.
(24) Consumption on the holding by cattle, sheep, pigs, or by horses other than those regularly employed on the holding, of corn, cake, or other feeding stuff not produced on the holding.
(25) Consumption on the holding by cattle, sheep, or pigs, or by horses other than those regularly employed on the holding, of corn proved by satisfactory evidence to have been produced and consumed on the holding.
(26) Laying down temporary pasture with clover, grass, lucerne, sainfoin, or other seeds sown more than two years prior to the determination of the tenancy.

The remaining subsection (27) relates to a holding to which the Market Gardeners' Compensation Act applies, regarding which and other sections bearing on that statute see under Market Gardens in a later volume.

The Agricultural Holdings Act of 1906 added the following improvements to the foregoing under Part III: 'Repairs to buildings, being buildings necessary for the proper cultivation or working of the holding, other than repairs which the tenant is himself under an obligation to execute'.

Section 9 (1) of the Act of 1900 enacts that references to 'manures' in the principal Act and this Act shall be construed as reference to the improvements numbered 23, 24, and 25 as in Part III of above Schedule.

It will be observed that home-grown as well as purchased corn is included in the feeding-stuffs for which there is a valid claim for compensation. But attention should be paid to the requirement that a record should be kept of the quantity produced and consumed on the farm. Unless such a record is kept, the claim for it might be disallowed by the arbiter, and in order to facilitate the work of the latter the record should state the class of stock consuming it as well as the place, including the land (if used outside) where it was consumed. The vouchers for purchased corn will of themselves be a record of that class of feeding-stuff used. The more fully and carefully such a record is kept, the stronger will be the outgoing tenant's evidence in support of his claim.

No. 26 under Part III, which was included for the first time in the Schedules in the Act of 1900, has not been happily expressed. The language seems to make the improvement consist in the laying down of the land by the sowing of the seeds specified. But the mere sowing of these being in itself no improvement, it has generally been held that it rather consists in continuing the land in temporary pasture for such a length of time that it constitutes a benefit to the holding. The Board of Agriculture has expressed the opinion—guided, we presume, by its legal advisers—that a tenant is entitled to be compensated only for the excess of pasture he leaves on removing from the farm above what he received in that state when he entered it. By section 1 (3) of the Act of 1900 it is enacted that 'in the ascertainment of the amount of the compensation payable to a tenant under the principal Act or this Act there shall be taken into account any benefit which the landlord has given or allowed to the tenant in consideration of the tenant executing the improvement'. The Board of Agriculture has said in effect that the temporary pasture on the farm at the commencement of the tenancy is to be regarded as a benefit to be treated *pro tanto*, as an offset to what is left in pasture at its close. This view has the recommendation that it is equitable between the parties. A tenant may be at liberty, according to the terms of his lease, to plough some land which he leaves in pasture, and by refraining to plough it, he is entitled to such compensation as may fairly represent the value of this to the incoming tenant. However, it ought to be borne in mind that merely leaving land in temporary pasture is not necessarily an 'improvement'. On the contrary, the land may thereby be deteriorated instead of being improved. Instances have occurred where a claim has been made for compensation for temporary pasture, and also a counter claim for deterioration for the same field, and where the tenant, instead of getting any compensation, was found liable in damage for deterioration.

FEEDING-STUFFS IN FARMYARD MANURE.—In many leases or farm agreements it is stipulated that the farmyard manure made but not applied to the land, after the sowing of the last crop, is to be taken over by the landlord or incoming tenant by valuation. It has been held by the courts in Scotland that under such circumstances the outgoing tenant is not entitled to compensation from the landlord for the residue of feeding-stuffs in such manure. Decisions to this effect were given by the Sheriff of Perth in the Ardgaith case, by the Sheriff of Dumfries and Galloway in the Steilston case, and the Sheriff of Aberdeen in the Mains of Williamston case. The decision in the first-mentioned case was submitted to eminent counsel, viz. Mr. J. B. Balfour (who later became Lord Kinross, President of the Court of Session), and to the late Lord Robertson, Scottish Lord of Appeal in the House of Lords, and they gave an opinion which agreed with the decision of the Sheriff of Perth. The main ground of the view given effect to in these decisions and opinion is that where the farmyard manure is valued, the price fixed is presumed to include its whole constituents from whatever source they may have come. Consequently, if an outgoing tenant under such circumstances had a valid claim for the residue of feeding-stuff, he would be paid two times for the same material, once by the proprietor, and a second time by the incoming tenant. Where the outgoing tenant is at liberty to remove the farmyard manure or to sell it to anyone other than the incoming tenant, the same law obviously applies. The amount of compensation in respect of an improvement made before 1st January, 1901, is to be such (if any) as could have been claimed under the Act of 1883, and as if the Act of 1900 had not been passed. Further, for the class of improvements introduced for the first time into the latter statute, compensation is only to be paid for such as were executed after that Act came into operation, viz. on 1st January, 1901.

CUMULATIVE OR EXCEPTIONAL FERTILITY.—In addition to what may be termed ordinary claims, cases have occurred for what has been designated by the not very happy phrases of 'cumulative fertility'. It has also been called 'exceptional fertility', 'increment', and 'betterment'. By this is meant a high degree of fertility in a holding produced by a liberal expenditure during a lengthened period on manures or feeding-stuffs, or both. The first phrase has been used on the ground that fertility has thereby been accumulated or heaped up in the soil to a degree which does not hold good by liberal applications of manure and the residue of feeding-stuffs during a comparatively short period. This matter falls to be noticed from the fact that not only have such claims been made, but in some cases awards have been pronounced giving effect to them, at least in part. In the case of Corsehope, for example, Mr. James Drennan, Ayr, the oversman in the arbitration, in addition to sums allowed for cakes, &c., consumed during the closing years of the tenancy, awarded a further amount of £300 to the outgoing tenant in the following terms, which are quoted here as the best means of explaining the ground on which a claim of this class has been allowed. The amount awarded was for—

'The value of improvements effected during the lease, over and above the remaining values of feeding-stuff and manures during the latter years of the lease, by the extensive and continuous consumption of feeding-stuff on the land—£300.'

The question of the legality of this portion of the award was brought before the sheriff, who upheld it.

In the Gribton case £150 was claimed and £75 was awarded for a similar claim made on the following terms: 'For exceptional fertility, on the ground of the outgoing tenant having during the occupancy of his farm (twenty-seven years) expended about £300 per annum on manure and feeding-stuffs, and the whole farm being in consequence in a very high condition'.

An unsuccessful effort was made to get an improvement included in the Schedule of the 1883 Act under the title of 'cumulative fertility'. The Royal Commission on Agriculture included in their recommendations the following: 'That it be made clear that power is given to referees to award compensation for long-continued use of manures', and it may be pointed out that by 1900 Act, section 9 (1), references to 'manures' are held to apply to the residue of feeding-stuffs as well as to fertilizers. There may be a difference of opinion as to the form in which such a claim should be given effect to under such phrases as cumulative or exceptional fertility, but unquestionably such a claim is founded on equity irrespective of the language in which it is expressed. It represents the real and existing improvement, especially as compared to an expenditure which has continued only for a limited number of years. Continuous good farming over a long series of years stores up fertility in the soil which in itself is valuable, and it also helps to make more recently-applied manures and the residue of feeding-stuffs last longer than where the liberal farming has been carried on only for a comparatively brief space of time.

Reduction of Claim for Manures, etc.—By subsections of section 1 of the Act of 1900, provision is made for the reduction of the compensation payable to a tenant on various grounds. By subsection (3), in the ascertainment of the amount of compensation payable there 'shall be taken into account any benefit which the landlord has given or allowed to the tenant in consideration of the tenant executing the improvement'. A tenant, for example, may be allowed a deduction of rent, liberty to break some covenant in the lease, or get some other concession, in consideration of his draining land or of his making some other improvement. But it should be noted that the benefit must be granted expressly in consideration of the tenant executing the particular improvement. To avoid disputes, if such an arrangement is made by the parties it should be made in writing, and clearly expressed. In the debate in Committee of the House of Lords in the English Bill, the Lord Chancellor (Selborne) stated that the provision covers the case of rent having been fixed with reference to an obligation on the part of the tenant to execute certain improvements.

Section 1 (4) is in these terms:—'In the ascertainment of the amount of the compensation payable to a tenant in respect of manures as defined by this Act, there shall be taken into account the value of the manure required by the contract of tenancy or by custom to be returned to the holding in respect of any crops sold off or removed from the holding within the last two years of the tenancy or other less time for which the tenancy has endured, not exceeding the value of the manure which would have been produced by the consumption on the holding of the crops so sold off or removed'.

The phraseology of the corresponding part of the Act of 1883 was obscure and perplexing, and the above is not much of an improvement on it. What it means seems to be as follows:—If it is brought to the knowledge of the arbiter, either by a claim on the part of the landlord or in any other way, that crops have been sold off or removed during the last two years of the tenancy, in breach of the provisions of the contract, he must take these into account in fixing the compensation for manures. If it is the custom of the district to apply manure in respect of the crops sold off or removed, and such manure has not been supplied, then the claim of the tenant will fall to be reduced to the extent of the value of the manure that would have been produced by the consumption on the holding of the crops so sold off or removed during the last two years of the lease. Or if the tenant is bound in the agreement or lease to apply a specified kind and quantity of manure in respect of crops sold off or removed, and if he has either failed to apply such manure, or having applied it has included it in his claim, a reduction will fall to be made.

A counter-claim by the landlord is not necessary to give effect to this subsection. Further, it does not deprive the landlord of his rights at common law for any breach of contract under the lease. Subsection (5) safeguards the right of a tenant to claim any compensation to which he may be entitled under custom, agreement, or otherwise, in lieu of any compensation provided by section 1.

Compensation by Agreement in Substitution of that Provided in the Acts.—Under certain limitations a landlord and tenant are permitted by the Acts to enter into private agreements as to the compensation to be paid by the former to the latter in substitution for the compensation provided for in the statutes. In respect of the improvements embraced in Part I and Part II of the First Schedule, there is no reason why their liberty should be curtailed in any way. Under the former the consent of the landlord is required to make the payment of any compensation obligatory on his part, and therefore as it may be withheld there is no call to require that it must be fair and reasonable. The tenant is also sufficiently protected as regards drainage under Part II, whether he executes the improvement himself or the landlord elects to do so. He can in one way or other get the improvement on fair terms, or at all events on terms settled by arbitration. However, ample safeguards are provided that the tenant will obtain compensation on fair and reasonable terms for such improvements specified in Part III as have been executed by him. These safeguards are the following:—

1. He is not required to obtain the consent of the landlord to the execution of the improve-

ments, and he has not even to give notice to him that he intends to make them.

2. He is deprived of the right to contract himself out of the rights conferred upon him by the Acts. Section 36 of the Act of 1883 is in the following terms:—'Any contract or agreement made by a tenant, by virtue of which he is deprived of his right to claim compensation under this Act in respect of any improvement specified in the Schedule hereto (except an agreement providing such compensation as is by this Act permitted to be substituted for compensation under this Act), shall, so far as it deprives him of such rights, be void'.

The reason why this section was inserted is quite obvious. One of the main objects of the statute was to encourage tenants to execute improvements on their holdings during the entire currency of it down to the close of the tenancy, and this object might be defeated if tenants were at liberty to contract themselves out of their statutory rights.

3. If a tenant does enter into a private agreement, it is not legal and binding unless it is an equitable one; in other words, the compensation substituted for that secured to him under the Acts must be 'fair and reasonable'. Section 5 of the Act of 1883 enacts:—

'Where, in the case of a tenancy under a lease beginning after the commencement of this Act (that is, after 1st January, 1884), any particular agreement in writing secures to the tenant for any improvement specified in the third part of the Schedule hereto and executed after the commencement of this Act, fair and reasonable compensation, having regard to the circumstances existing at the time of making such agreement, then in such case the compensation in respect of such improvement shall be payable in pursuance of the particular agreement and not under this Act'.

It will be observed that such a private agreement must be in writing. Where such a contract has been entered into, the outgoing tenant does not, in so far as the compensation provided in it is concerned, require to give the notice to the landlord required by the Acts. Its adjustment will fall to be made either between the parties or under the arbitration provisions of the statute. What is 'fair and reasonable' compensation will depend on the circumstances of each case. But it might not be so on various grounds, the leading one being that it might not secure to the tenant such full compensation as he would obtain under the Act. Any agreement which provides for compensation being paid for feeding-stuffs consumed on permanent pasture and excluding what was used in houses, or say by sheep folded on turnips, would not be fair and reasonable, inasmuch as it might and probably would exclude the greater part of the feeding-stuffs consumed on the holding. Again, an agreement providing for the residue of linseed cake being paid for and for all other kinds of feeding-stuffs being disallowed, would not be legal. The same may be said of a condition that the tenant is not to have any claim for more manures or feeding-stuffs used during the last two or three years of the lease than during the preceding years of the tenancy.

It may be well to warn tenants against signing any agreement of this kind which does not seem for them 'fair and reasonable compensation'. If signed, the burden will rest on them to show that the terms agreed on are not fair and reasonable, and they should proceed on the assumption that neither an arbitrator nor a law court will lightly set them aside. Substantial injustice must be the effect of these to warrant their being declared null and void.

The Act does not specify, in a case where the tenant wishes to set aside the particular agreement into which he has entered, what tribunal or person is to be authorized to sit in judgment on the question at issue.

But the matter has been set at rest by a decision of the Court of Session in the case of Bell *v.* Graham arising out of the Wyseby Mains reference. There was a substituted schedule under the lease to which the tenant objected under the arbitration as not being 'fair and reasonable'. Upon the question being brought before the sheriff, he decided that the arbiter must give effect to the schedule unless and until the same is set aside or reduced by a court of law. An appeal on the part of the tenant was heard before seven judges of the Court of Session. The question submitted was 'Whether the arbiter is entitled to set aside or ignore as void the agreement contained in the lease providing for compensation according to a specified scale, if in his opinion fair and reasonable compensation is not thereby substituted'. By a majority of five to two it was decided that it falls to the arbiter to decide whether the substituted agreement is fair and reasonable, but that he must judge of its fairness and reasonableness as viewed in the circumstances at the time of making it, and not whether it did or did not tally with the scale which the arbiter if left to himself would now apply; further, that the agreement being signed by both parties, the objector must specify the provisions objected to and the reason for his objections. However, the Court indicated that the arbiter's judgment, if challenged, would not be final, but might be brought before a court of law.

COMPENSATION FOR REPAIRS ON BUILDINGS.—The Agricultural Holdings Act, 1906, added the following to Part III of the First Schedule of the 1900 Act:—

'Repairs to buildings, being buildings necessary for the proper cultivation or working of the holding, other than repairs which the tenant is himself under an obligation to execute.'

'Provided that the tenant, before beginning to execute any such repairs, shall give to the landlord notice in writing of his intention, together with particulars of such repairs, and shall not execute the repairs unless the landlord fails to execute them within a reasonable time after receiving such notice.' (Section 6.)

This is so clear and plain that it does not require to be elaborated or emphasized. We merely point out that the power is limited to execute repairs to erected buildings of a suitable character for the particular holding, and that the tenant, before proceeding to execute them, must give notice, accompanied by particulars, to the landlord, so that the latter may have the opportunity of making the repairs should he elect to do so.

Tenant's Property in Fixtures.—By section 30 of the Act of 1883 a tenant is entitled, on quitting the holding, to remove fixtures, including 'any engine, machinery, fencing, or other fixture', and also buildings erected by him, provided two conditions are complied with, viz.:

(1) That one month before removing any fixture or building, the tenant shall give notice to the landlord of his intention to do so, and within that time the latter may give notice to the former that he elects to purchase it at a price equivalent to the fair value of it to an incoming tenant, to be fixed by the arbitrator provided under the Acts (but without appeal); and—

(2) That the tenant must make good any damage done to the holding in removing the fixtures or buildings.

By Act 1900, section 4, the foregoing provisions apply to fixtures or buildings acquired from his predecessor by a tenant the same as those affixed or erected by himself.

Freedom of Cropping and Disposal of Produce.—By section 3 (1) of the Agricultural Holdings Act of 1906, the right of freedom of cropping and disposal of produce under certain conditions are conferred upon the tenant on the following terms:—'Notwithstanding any custom of the country or the provisions of any contract of tenancy or agreement respecting the method of cropping of arable lands or the disposal of crops, a tenant shall have full right to practise any system of cropping of the arable land on his holding and to dispose of the produce of his holding without incurring any penalty, forfeiture, or liability; provided that he shall previously have made, or as soon as may be he shall make, suitable and adequate provision to protect the holding from injury or deterioration'. It is specified that in the case of disposal of the produce of the holding the foregoing provisions shall consist in the return to the holding of the full equivalent manurial value to the holding of all crops sold off or removed from the holding in contravention of the custom, contract, or agreement.

It will be observed that what is to be applied is the 'full equivalent manurial value'. The chief difficulty likely to be encountered in the administration of this provision will probably be in determining how the equivalent of the manurial residue from forage crops containing organic matter or humus, if these are sold off or removed, can be provided. Obviously this would not be done if only mineral fertilizers were applied. Especially on light, gravelly land decayed vegetable matter is more apt to be exhausted than on heavier and more retentive soils, and its presence is important if not even essential to the high fertility of such land. However, difficulties may not be too readily raised until they actually arise in practice.

Where the holding is occupied on a yearly tenancy, this section conferring freedom of cropping and sale of produce is not to apply as respects the year before the tenant quits the holding, or any period after he has given or received notice to quit which results in his quitting the holding. Where the tenancy is for a longer period than a year, this freedom of cropping and sale of produce is not to be exercised during the year before the expiration of the contract of tenancy. Further, the tenant is debarred from breaking up what is probably specified in the lease as permanent pasture (section 3 (4)).

The interests of the landlord are so far protected by the provision that if the tenant exercises these rights in such a manner as to injure or deteriorate the holding the landlord shall, without prejudice to any other remedy which may be open to him, be entitled to recover damages in respect of such injury or deterioration at any time; and should the case so require, to claim an injunction, or in Scotland an interdict, restraining the exercise of such right, and the amount of such damages may in default of agreement be determined by arbitration. It thus provides that the landowner can ask the court to prevent the tenant exercising the rights of freedom of cropping and sale of produce, and further, he can obtain damages if he succeeds in proving that he has sustained them. In the event of the parties failing to agree as to the amount due as damages, it is only permissive for them to have it settled by arbitration; otherwise it seems it would be dealt with as an alleged debt at common law. Any expenditure which a tenant may incur in protecting the holding from injury under this section is not to be included as an improvement under Part III of the First Schedule to the Act of 1900.

Record of Holding.—Either the landlord or the tenant may require at the commencement of a tenancy that a record of the condition of the buildings, fences, gates, roads, drains, ditches, and cultivation of the holding shall be made within three months by a person to be appointed by the parties, or, in default of agreement, by the Board of Agriculture and Fisheries. (Act 1906, section 7.) In default of agreement the cost thereof is to be borne by the parties in equal proportions. There are many holdings in regard to which such an authoritative record would be useful in adjusting matters at the end of the tenancy, and also during its currency.

Penal Rents.—What are popularly known as 'penal rents' were abolished by section 6 of the Act of 1900. However, they may still be enforced in regard to the breach of any covenant or condition in the agreement against 'breaking up permanent pasture, grubbing underwoods, or felling, cutting, lopping, or injuring trees, or regulating the burning of heather'. For breaches of the lease otherwise, the landlord can now only recover payment for the actual damage proved to have been sustained by him.

Bequest of Lease.—Before the Act of 1883 came into force, the tenant of a holding under a lease could not bequeath it to anyone. Where no stipulation was made, the right of tenancy at his death passed to his heir. By section 29 of that statute 'a tenant may by will or testamentary writing bequeath his lease to any person (called "the legatee")', subject to certain conditions, the principal of which are as follows:—

(1) Within twenty-one days of the death of the lessee, the legatee must intimate the testamentary bequest to the landlord or his known agent. However, it should be noted that the taking of this step imports acceptance of the lease on the part of the legatee.

(2) Within one month after receiving such intimation the landlord may give notice to the legatee that he objects to accept him as tenant.

(3) When such an objection has been taken, the legatee may petition the sheriff to dispose of the matter, and his decision shall be final.

NOTICE OF DETERMINATION OF TENANCY.—Where a lease is for three years or upwards, the one party must give written notice to the other party, not less than one year or more than two years before the termination of the lease, of his intention to bring the tenancy to an end. When a lease is from year to year, or for any period less than three years, the written notice must be given not less than six months before the termination of the tenancy. Failing such notice, the lease shall be held to be renewed by tacit relocation for another year, and thereafter from year to year (Act 1883, section 28).

COMPENSATION FOR UNREASONABLE DISTURBANCE.—This was provided for for the first time in the Act of 1906, section 4, in the following terms:—'Where the landlord without good and sufficient cause, and for reasons inconsistent with good estate management, terminates a tenancy by notice to quit, or after having been requested in writing at least one year before the expiration of a tenancy to grant a renewal thereof, refuses to do so, or where it has been proved that an increase of rent is demanded from the tenant, and that such increase was demanded by reason of an increase in the value of the holding due to improvements which have been executed by or at the cost of the tenant, and for which he has not either directly or indirectly received an equivalent from the landlord, and such demand results in the tenant quitting the holding, the tenant upon quitting the holding shall in addition to the compensation (if any) to which he may be entitled in respect of improvements, and notwithstanding any agreement to the contrary, be entitled to compensation for the loss or expense directly attributable to his quitting the holding which the tenant may unavoidably incur upon or in connection with the sale or removal of his household goods or his implements of husbandry, produce, or farm stock on or used in connection with the holding'.

'Provided that no compensation under this section shall be payable—

(*a*) Unless the tenant has given to the landlord a reasonable opportunity of making a valuation of such goods, implements, produce, and stock, as aforesaid; or

(*b*) Unless the tenant has within two months after he has received notice to quit or a refusal to grant a renewal of the tenancy, as the case may be, given to the landlord notice in writing of his intention to claim compensation under this section; or

(*c*) Where the tenant with whom a contract of tenancy was made has died within three months before the date of the notice to quit, or in the case of a lease, for years before the refusal to grant a renewal; or

(*d*) If the claim for compensation is not made within three months after the time at which the tenant quits the holding.'

In the event of any difference arising as to any matter under this section, the difference shall, in default of agreement, be settled by arbitration.

COMPENSATION FOR DAMAGE BY GAME.—By the Ground Game Acts, occupiers of land are protected from the ravages of ground game, but have no right to destroy other game. Where a tenant suffers from other game, he can claim damages only if he prove that the stock of game on the ground at the commencement of the tenancy has been increased to an excessive extent—a claim somewhat difficult to substantiate. This difficulty has been met after 1st January, 1909, by the provisions of section 2 of The Agricultural Holdings Act, 1906, which are as follows:—

Where damage to crops is done by game, which the tenant has not the right to kill, he shall be entitled to compensation under the following conditions:—

(1) The damage must exceed 1*s.* per acre of the area over which the damage extends.

(2) Written notice must be given, as soon as possible after damage first observed.

(3) Landlord must have reasonable opportunity to examine damage—(*a*) In case of growing crop, before it is reaped, raised, or consumed; and (*b*) in case of raised or reaped crop, before removal from land.

(4) Written particulars of claim to be given within one month of expiry of year for which claim made.

Failing agreement, compensation shall be settled by arbitration. In cases of leases current at 1st January, 1909, deduction from compensation shall be made for any sum or allowance in respect of game damage expressly fixed by the lease. After the date of the Act, any agreement in limitation of the compensation fixed by the Act, shall be void.

The landlord is liable in the first instance to the tenant, but is entitled to be indemnified by his game tenant, if any.

For the purposes of the Act game means deer, pheasants, partridges, grouse, and black game.

PROCEEDINGS UNDER ARBITRATION.—Under the Act of 1900, if the parties fail to agree as to the compensation to be paid, it is provided that it is to be determined by an arbiter or by two arbiters mutually chosen, and the oversman as the parties might arrange. But the statute of 1906 enacts that all questions under the Agricultural Holdings Acts, 1883 to 1906, or under the contract of tenancy, which are referred to arbitration shall, whether the matter to which the arbitration relates arose before or after the passing of that Act, be determined, notwithstanding any agreement to the contrary, by a single arbitrator. Consequently, after 1st January, 1909, the employment of a single arbiter shall be compulsory and universal. The procedure is laid down in the Second Schedule appended to the Act of 1900. If the parties fail to agree in nominating a person as sole arbiter, either of them can apply to the Board of Agriculture, who shall make the nomination. The Board of Agriculture has prescribed forms for this and for the award, which should be made use of.

If, in addition to his claim for compensation for improvements under the Acts, the tenant has any unsettled claim against the landlord 'in respect of any breach of contract or otherwise in respect of the holding', he can bring the settlement of such additional claim within the arbitration proceedings. If he gives written notice to the landlord, by registered letter or otherwise, not later than seven days after the appointment of the arbiter, requiring that the arbitration shall extend to the determination of the further claim, the landlord has no alternative but to acquiesce in this course being pursued. In the same way, if the landlord has any claim against the tenant 'in respect of any waste wrongfully committed or permitted by the tenant, or in respect of breach of contract or otherwise in respect of the holding', by giving notice to the tenant not later than seven days after the appointment of the arbiter (as above explained), he can require the matter to be disposed of under the arbitration proceedings. There is no limitation made in the length of time that the compensation for deterioration or breach of contract can be claimed for. Of course, if these additional questions are not brought within the arbitration proceedings in the way described, either party is left free to raise and prosecute them at common law. Act 1900 2 (3).

The arbiter can require the parties to submit themselves for examination in relation to the matters in dispute, and to produce all samples, accounts, documents, &c., in their possession or power which may be required or called for. He has power to administer oaths, and to take the affirmation of parties and witnesses. Any person who wilfully and corruptly gives false evidence before an arbiter is held to be guilty of perjury, and may be dealt with, prosecuted, and punished accordingly. The arbiter may at any stage of the proceedings, and shall if so directed by the judge of a county court (in Scotland the sheriff), which direction may be given on the application of either party, state in the form of a special case, for the opinion of that court, any question of law arising in the course of the arbitration.

THE AWARD.—The arbiter is required to make and sign his award within twenty-eight days of his appointment, or within such longer period as the Board of Agriculture may (whether the time for making the award be expired or not) direct. The form prescribed by the Board of Agriculture, contained in the appendix hereto, should be followed. On the application of either party, the arbiter shall specify the amount awarded in respect of any particular improvement or improvements. The award shall fix a day, not sooner than one month nor later than two months after delivery of the award, for the payment of the money awarded for compensation, costs, or otherwise. It is final and binding on the parties.

It is laid down in section 10 (4) of the 1900 Act that 'any award or agreement as to compensation and any other award under this Act may be competently recorded for execution in the books of Council and Session or Sheriff Court books and shall be enforceable in like manner as a recorded decree'. This gives the award by the arbiter the position and authority of a decision by the court.

The costs of and incidental to the arbitration and award are in the discretion of the arbiter. He may direct to and by whom and in what manner these costs or any part thereof are to be paid. The costs are subject to taxation by the registrar of the county court (auditor of the sheriff court in Scotland) on the application of either party, but the taxation is subject by the judge of that court. In awarding costs, the arbiter is to take into consideration the reasonableness or unreasonableness of the claim of either party, either in respect of amount or otherwise, and any unreasonable demand for particulars or refusal to supply particulars, and generally all the circumstances of the case; and he may disallow the costs of any witnesses whom he considers to have been called unnecessarily, and any other costs which he considers to have been incurred unnecessarily. [J. G.]

The following are forms prescribed by the Board of Agriculture to be used:—

FORM A

Form of Award

Agricultural Holdings Acts, 1883 to 1900

Insert name (if any) and description of holding.

In the matter of a holding known as , lately in the occupation of A.B., of (*the quitting tenant*).

To all to whom these presents shall come I, F.G., of , [we, F.G., of , and H.K., of ,] send greeting.

Whereas C.D., the landlord of the above-mentioned holding, and the said A.B., the tenant thereof, have failed to agree as to the amount and time and mode of payment of the compensation to which the said A.B. claims to be entitled in respect of the improvements made on the above-mentioned holding, which are comprised in the First Schedule to this Award.

(Here insert recitals of appointments of Arbitrator, Arbitrators, or Umpire. See Forms B., C., and D.)

And whereas the said A.B., by written notice to the said C.D., has required that the arbitration shall extend to the determination of certain further claims by the said A.B. against the said C.D. in respect of the said holding, the short particulars of which claims are set forth in the Second Schedule to this Award.

And whereas the said C.D., by written notice to the said A.B., has required that the arbitration shall extend to the determination of certain claims by the said C.D. against the said A.B. in respect of the said holding, the short particulars of which claims are set forth in the Third Schedule to this Award.

And whereas the said A.B. *or* C.D. has applied to me [us] to specify the amount awarded in respect of such of the improvements comprised in the First Schedule to this Award as are in such Schedule marked with an asterisk.

And whereas the time for making my [our] Award has been extended by the Board of Agriculture to the day of , 19 , .

or

And whereas we have duly enlarged the time for making our Award to the day of , 19 .

Now know ye that I, the said F.G. [we, the said F.G. and H.K.], having taken upon myself [ourselves] the burden of the said reference, and having heard, examined, and considered the witnesses and evidence concerning the said matters so referred to me [us] as aforesaid, do make and publish this my [our] Award of and concerning the same in manner following, that is to say:—

1. I [We] award and determine that the said A.B. is entitled to receive from the said C.D. the sum of pounds shillings and pence, as compensation in respect of the improvements comprised in the First Schedule to this Award, and I [we] do hereby declare that the amounts awarded by me [us] in respect of such of the said improvements as are marked with an asterisk are the amounts set against such improvements in such Schedule.

2. I [We] award and determine that the said A.B. is entitled to receive from the said C.D. the sum of pounds shillings and pence in respect of the claims mentioned in the Second Schedule to this Award.

3. I [We] award and determine that the said C.D. is entitled to receive from the said A.B. the sum of pounds shillings and pence in respect of the claims mentioned in the Third Schedule to this Award.

4. I [We] award and determine that the said sum[s] of pounds shillings and pence [and pounds shillings and pence] awarded by me [us] shall, subject to the provisions of the Agricultural Holdings (England) Acts, 1883 to 1900, be paid by the said C.D. to the said A.B. on the day after the delivery of this Award; and that the said sum of pounds shillings and pence awarded by me [us] shall, subject as aforesaid, be paid by the said A.B. to the said C.D. on the same day.

Note.—The date in paragraphs 4 and 5 must not be earlier than one calendar month, nor later than two calendar months, after the delivery of the award.

5. I [We] award and direct that the costs of and incidental to the arbitration and this Award shall be paid by the said A.B. *or* C.D. *or* by the said A.B. and C.D. in the following proportions, namely, part thereof by the said A.B. and part thereof by the said C.D. [*or otherwise as may be directed*], *or* I [We] award and direct that each party shall bear his own costs of and incidental to this arbitration, and shall pay part of my [our] costs of this Award, and that any costs payable by the one party to the other party under or by virtue of this Award shall be so paid on the day after the delivery of this Award.

See note above.

In witness whereof I [we] have hereunto set my [our] hand[s] this day of 19 .

Signed by the said F.G. [and H.K.] in the presence of

F.G.
[H.K.]

THE FIRST SCHEDULE REFERRED TO IN THE ABOVE-WRITTEN AWARD

(Here insert each of the improvements comprised in the First Schedule to the Agricultural Holdings Act, 1900, in respect of which a claim by the tenant has been referred to arbitration. If either party has required that the amount awarded in respect of any particular improvement shall be specified, the person or persons making the Award will mark such improvement with an asterisk, and place against the improvement the amount awarded in respect thereof.)

THE SECOND SCHEDULE REFERRED TO IN THE ABOVE-WRITTEN AWARD

(Here insert short particulars of any further claim by the tenant to which he has by written notice required that the arbitration shall extend.)

THE THIRD SCHEDULE REFERRED TO IN THE ABOVE-WRITTEN AWARD

(Here insert short particulars of any claim by the landlord to which he has by written notice required that the arbitration shall extend.)

NOTE.—The Award may be endorsed as follows:—

This Award was delivered to A.B. [*or* C.D.] on the day of 19

F.G.
[H.K.]

FORM E

(Application for Appointment by Board of Agriculture of a single Arbitrator.)

Agricultural Holdings Acts, 1883 to 1900

TO THE BOARD OF AGRICULTURE.

Insert name (if any) and description of holding.

In the matter of the holding known as , lately in the occupation of A.B., of *(the quitting tenant).*

Whereas the said A.B. claims to be entitled to compensation in respect of certain improvements made on the above-mentioned holding.

And whereas C.D., of , the landlord of the said holding, and the said A.B., have failed to agree as to the amount and time and mode of payment of such compensation, and as to the person to act as arbitrator for the purpose of settling the differences that have so arisen.

And whereas there is not any provision in any agreement between the said A.B. and C.D. relating to the appointment of such arbitrator, and such arbitrator may accordingly be appointed by the Board of Agriculture on the application in writing of either of the parties.

Now I, the said A.B. *or* C.D., do hereby apply to the Board of Agriculture for the appointment by them of an arbitrator for the purpose of settling the said differences.

(Signature of A.B. *or* C.D., or his duly authorized agent.)

NOTE.—*Delay in making the appointment will be avoided if the application is signed by or on behalf of both parties.*

FORM H

(Application to Board of Agriculture for extension of time for Award.)

Agricultural Holdings Acts, 1883 to 1900

TO THE BOARD OF AGRICULTURE.

Insert name (if any) and description of holding.

In the matter of an arbitration under the above-mentioned Acts between A.B., of *(the quitting tenant)*, and C.D., of *(the landlord)*, relating to the holding known as , lately in the occupation of the said A.B.

Whereas the time for making the Award in the said arbitration will expire [*or* expired] on the day of , 19 .

Now I, the undersigned, do hereby apply to the Board of Agriculture to extend the time for making the said Award to the day of , 19 .

[This may be signed by an arbitrator, or by an umpire, where the matter is referred to him, or in any case by either party to the arbitration or his duly authorized agent.]

For methods of assessing compensation for manures and feeding-stuffs under the Agricultural Holdings Acts, see art. COMPENSATION.

Agricultural Organization Societies. See ORGANIZATION.

Agricultural Rates Act. See RATING.

Agricultural Schools and Colleges. See EDUCATION.

Agricultural Shows.—The object of these has mainly been to induce agriculturists to improve the live stock of the farm, and unquestionably they have exerted a great influence in this direction. For centuries the specimens of the different breeds of horses, sheep, and cattle were poor. They were the more so because they were poorly kept in many cases in winter—indeed they were not infrequently treated in a way that was little short of starvation. The growth of towns and cities by and by created a demand for beef and mutton which awakened on the part of the owners a desire to improve their animals. The distance of the principal centres of population from many parts of the country was a serious obstacle in the way of stock owners finding a ready and remunerative market for their cattle and sheep. The latter for long were bred and reared principally for their wool. As markets and other outlets provided facilities for the disposal of their surplus stock at slightly enhanced prices, a desire to improve their animals gradually sprang up and extended. This led to a demand for animals, specially males of an improved sort, and no doubt it was the fostering of this spirit which led to agricultural shows being held all over the country. For long, owing to the poor facilities for travelling, the live-stock exhibitions were necessarily of a purely local character. Each district had its own show, the classes being confined to the breeds kept in the respective localities. The classification in former days was often different from what is now commonly adopted. For example, in addition to prizes for the best individual animals of each class, it was not uncommon for a class of some such nature as the following to be provided: for the best lot of yearlings, excluding bulls—being not less than one half of the cattle bred on the farm. Such a classification recognized and encouraged the attainment of a high degree of merit on the part of the stock on a farm, and moreover, the occupants of moderate-sized farms were put on a fair level with those whose animals were more numerous, inasmuch as the criterion by which the award was given was the average merit of the beasts, apart from the number which might be exhibited. In former times, landowners not infrequently offered prizes for the most meritorious lot of cattle of a particular age, bred by their tenants. Sir James Graham, Bart., of Netherby, had a special but useful method of encouraging and rewarding his tenants. He had a herd which was acknowledged to be the best in the district, and the prizes consisted of bull calves—the successful competitors getting their choice after each other in the order in which they stood on the prize list. The establishment of breeding shows was followed by fat-stock exhibitions. Shows of roots, grain, and seeds have long been common, and at almost all exhibitions, whether of the live or dead stock of the farm, implements have been conspicuous. At almost every exhibition, for a long time, prizes were given for the most approved implements and machines used by farmers. But this has latterly been discontinued, with the general approval of the exhibitors themselves. The awards were not regarded as satisfactory unless they were pronounced after most thorough trials, and this was not always practicable. Besides, the public were apt to be misled, say, by an implement being extensively advertised as having been awarded the first prize by one of the national agricultural societies, long after it had been superseded by a new or improved machine which by general consent was better adapted for the purpose. [J. G.]

Agricultural Societies.—At an early date agriculturists entered into combinations called societies or associations, for the purpose of promoting objects common to them all. In the nature of the case, for a long time these were confined to a comparatively limited geographical area. Before the days of railways the means of communication between different districts were limited and slow, so that only a small proportion of those actively engaged in the farming industry went far from home. But there were generally a few in most districts who interested themselves in imparting useful knowledge to others as to the best methods of growing and consuming crops, including the introduction of improved machinery. The improvement of the live stock on the farms was also one of the objects steadily kept in view, but the progress made in this department was for a long time slow. One of the first societies instituted was called the Honourable Society of Improvers in the Knowledge of Agriculture in Scotland. This organization, which had its headquarters in Edinburgh, was started in 1723. It was almost entirely composed of landowners, and its most active member was Mr. Robert Maxwell of Arkland, in Kirkcudbright, who published an account of its operations in 1743. It encouraged the formation of branch societies over Scotland. It fostered improved methods of farming, and encouraged farmers and others in all parts of the country to apply to it for information and advice, which were freely given. The improvement of landed property was the main object aimed at, but in this way tenant farmers indirectly derived no inconsiderable advantage. In fact, that class and gardeners were admitted free as members. A similar society was by and by set up in Ireland, and various organizations having the same object were set agoing in England. The Highland Society of Scotland was instituted in 1784. At first it was confined to the Highlands, and its promoters sought through its agency to preserve the language, the poetry, and the music of that part of Scotland. When it got a Royal Charter in 1834 its name was changed to that of the Highland and Agricultural Society of Scotland, and subsequently the advancement of agriculture in all parts of North Britain was regarded as its special aim. The sister organization, the Royal Agricultural Society of England, was instituted by Royal Charter in 1839. Another important society which is more limited in its scope, though it embraces an extensive territory, is the Bath and West of England Society. All the provincial agricultural societies, as well as the national ones, sought to encourage and introduce improved systems of farming, as well as to improve the live stock of the farm. In many instances experiments in the growth of crops were conducted by the members, and by such means the progress made was decidedly more rapid than would have been the case had farmers been left to act independently and feel their way for themselves. The most economical and profitable methods of consuming the crops of farms also engaged at a comparatively early date the attention of these societies. In the early days of which we are speaking, not much assistance was given by the press in the dissemination of knowledge regarding farming matters. But it was customary for the members to have discussions among themselves, which were useful not only as a means of imparting information, but also in awakening and fostering a spirit of enquiry and a desire for the introduction of improvements. Latterly not a few agricultural societies have almost entirely confined their work to holding shows for live stock and implements. This is to be regretted, inasmuch as, while these exhibitions are useful, much good in other ways might be accomplished by such organizations.

The following are the principal agricultural societies in the United Kingdom:—Ayrshire Agricultural Association, Ayr; Bath and West and Southern Counties Society, Bath; Birmingham Agricultural Exhibition Society; Glasgow Agricultural Society, Glasgow; Highland and Agricultural Society, Edinburgh; International Horse Show Association, London; Royal Agricultural Society of England, London; Royal Counties Agricultural Society, Basingstoke; Royal Dublin Society, Dublin; Royal Northern Agricultural Society, Aberdeen; Royal Ulster Agricultural Society, Belfast; Scottish National Fat Stock Club, Leith; Smithfield Club (Incorporated), London; Welsh National Agricultural Society, Aberystwyth.

Readers may also consult the articles BATH AND WEST AND SOUTHERN COUNTIES SOCIETY, HIGHLAND AND AGRICULTURAL SOCIETY, ROYAL AGRICULTURAL SOCIETY OF ENGLAND, ROYAL DUBLIN SOCIETY. For the various live-stock societies see under the different breeds.

[J. G.]

Agriculture, Chambers of.

I. ENGLAND AND WALES.—The English Chamber of Agriculture, or, to give it its proper designation, the Central Chamber of Agriculture, was founded in 1866, simultaneously with the formation of local Chambers in different parts of the country, which were affiliated to the central body under the title of the Central and Associated Chambers of Agriculture, the object being 'to promote and advance the best interests of agriculture, and with that view to watch over all measures affecting the agricultural interests before Parliament, and to take such action on all matters, both in and out of Parliament, as might seem desirable for the benefit of agriculture'.

Since its institution, the Chamber has considerably enlarged its field of work, and has embraced agricultural societies, unions, federations, dairy associations, &c., in addition to the original Chambers and farmers' clubs. The number of bodies now associated is 90, representing, with the Central Chamber, a membership of some 17,000 or 18,000. The Central Chamber has the advantage of having on its roll 136 members of the Legislature, of whom 83 are members of the House of Commons. The total membership is 350.

The work of the Chamber is undertaken by a Council, which consists of 24 members chosen out of, and by the subscribing members of the Central Chamber, and in addition 110 deputies appointed annually by the various federated bodies. The Council meets in London once in each of the months of February, March, April, May, June, November, and December. The subjects for discussion are selected by a business committee representative of both the Central and Associated Chambers. In addition to this general business committee other committees are appointed from time to time to deal with special branches of the agricultural interest. The special committees at present in charge of remits from the General Committee are comprised in the following list:—Parliamentary Committee, Local Taxation Committee, Cattle Diseases Committee, Dairy Products Committee, Organization Committee, Railway Rates Committee, Fertilizers Committee.

The financial resources of the Chamber are limited. Nevertheless, useful work has been done in the past, and the influence of the Chamber has manifested itself in connection with the various parliamentary measures that have emerged since its institution. The above-mentioned committees sufficiently indicate the present activity of the Chamber, and an open invitation is extended to all those agricultural bodies not yet federated with the Central Chamber, to become associated at once and so consolidate the interests of all those who are working for, and interested in, the welfare of British agriculture. The truth of the assertion is obvious 'that unless agriculturists are prepared to efficiently maintain an organization for the furtherance of their own industry, they cannot complain if other interests, more alert, should receive greater consideration from Parliament'.

II. SCOTLAND.—The constitution and aims of the Scottish Chamber of Agriculture are similar to those of the corresponding body in England, with which it is in corresponding membership. The affiliated and associated societies number at present 76, with a total membership of close upon 18,000. Rule 7 of the constitution provides for the management of the Chamber by a direction consisting of a president, two vice-presidents, and at least twenty-five directors, the majority of whom are tenant farmers. The election to the directorate is made at the annual general meeting.

The objects of the society are, in the main, similar to those of the English Chamber. In particular, the Chamber seeks to attain its objects 'by meetings and conferences (public or otherwise), at which any subject connected with, related to, or affecting agriculture, and especially agricultural legislation and administration, may be discussed and resolutions adopted; by presenting petitions and sending deputations to parliament, or to any government or public department or board regarding such matters'.

Agriculture, History of. — That the origin of the art of agriculture dates back far beyond the period of the most ancient history is obvious from the fact that the earliest detailed records of it represent it as in a considerably advanced stage. But the origin, although not actually known, is not difficult to imagine. Primitive races of mankind, if they subsisted partly or wholly upon wild fruits and seeds, could not have failed to observe self-sown plants springing up in the soil around those from which they gathered the produce, and no great degree of intelligence was necessary to suggest the covering of seeds with soil in places convenient for obtaining the results of such primitive enterprise. It is true that some nomadic races, living on the fruits of the chase and the products of wild vegetation, have failed to practise agriculture even in its most primitive form down to the present time, and it may be surmised, therefore, that scarcity was the hard schoolmaster to suggest in the first instance the artificial production of food, where population became comparatively thick and game and wild fruits correspondingly short, or tropical drought frequently reduced the natural products of the soil below the subsistence level. Equally easy is it to imagine the origin of the domestication of some of the wild animals of the world for the supply of meat and milk, and, in course of time, for draught purposes.

Apart from the Scriptural account of the origin of mankind, in which Cain and Abel are incidentally named as the representatives of the two main branches of agriculture, while Noah, some time later, is mentioned as having planted a vineyard, and Abraham as being a great owner of cattle, sheep, asses, and camels, there is evidence of agriculture having attained considerable development many centuries before the Christian era. Abraham's visit to Egypt was illustrative of the common practice of nomadic tribes in neighbouring countries resorting to that country for subsistence in times of famine. Moreover, as pointed out by Mr. Chandos Wren Hoskyns in his Inquiry into the History of Agriculture, in the tomb of Rameses III, one of the shepherd kings of ancient Egypt, in the British Museum, the shepherd's crook, which had become a royal badge, is to be seen in one of the monarch's hands; and yet the period in which the sheep husbandry was paramount in Egypt, some centuries in duration, had been preceded, as it was followed before the time of Joseph, by an era of pre-eminent tillage. At the time of Joseph Egypt was the granary of its part of the world, and probably it had been so for centuries before. The plough, though of a pattern different from any ever used in this country, and other agricultural implements were in use; there were various breeds of live stock; and poultry were hatched by a primitive method of artificial incubation. Hieroglyphics on ancient monuments are indelible records of the early development of agriculture in Egypt. The agricultural classes, too, appear to have been highly organized.

The ancient writers of Greece and Rome have much to say about the agriculture of Egypt and some neighbouring countries. If all their stories were to be taken as strictly accurate, it might be concluded that farming had degenerated since their time; for they state that in Egypt, and ancient Assyria also, a yield of corn one hundredfold the quantity of seed sown was common, and even mention yields of two hundredfold. The latter increase, at least, is quite incredible; for, even if only a bushel of corn was sown, two hundred times that quantity is far beyond the accredited production of any cereal in any part of the world.

To the Saracens, as the Arabian tribes who embraced the religion of Mohammed were generically named, Mr. Hoskyns ascribes great credit for the introduction into the European countries which they invaded of some of the most advanced methods of land culture in Egypt, Syria, and Persia, and particularly as the introducers of irrigation and draining into Europe.

Among other countries in which agriculture attained more or less considerable development in ancient times are China and Hindustan; but the records, like those of ancient Greece, are lamentably scanty. In the case of the last-named country, indeed, this scantiness is surprising in comparison with the full accounts of other subjects of national interest given by her famous historians. On the other hand, very full accounts of the husbandry of ancient Rome are extant in the works of Pliny, Virgil, Cato, Columella, Varro, and Palladius, while those of many other writers have been lost.

The full details given by Roman writers show that agriculture was carefully studied and practised in their time by their fellow countrymen. The importance of rotation in cropping was fully understood, and the fertilizing effect of growing leguminous crops was distinctly recognized, while strict rules as to tillage, manuring, times of sowing, and other details were laid down by the best authorities, and commonly observed. It is true that a wide-spread superstition as to the connection of phases of the moon with the best times for sowing and other operations prevailed; but even modern British farmers are not quite free from that delusion. Directions for the choice, breeding, feeding, and management of cattle had a bearing more upon the animals considered as draught oxen than upon their suitability for the production of meat.

In an encyclopædia of modern agriculture full details of the farming of ancient times would be out of place, and readers who desire to become acquainted with those of the Romans, if not able to study them in the works of the authors named above, may be referred to the full account of the subject given in The Husbandry of the Ancients, by the Rev. Adam Dickson, A.M., in two volumes, published in Edinburgh in 1788 by J. Dickson and W. Creech, and Daubeny's Lectures on Roman Husbandry (1857).

The Romans implanted their agricultural system more or less fully in the countries which they subjugated and colonized, and their influence upon the agriculture of Britain during four centuries of occupation could not have failed to be of great importance. Unfortunately, history is silent as to the condition in which the conquerors found British agriculture when they first entered this country or during their occupation of a considerable part of it. Under their sway, however, it is certain that agriculture flourished, until Britain became a great corn-exporting country.

Whether the industry deteriorated or not under the Saxons there is no clear evidence to show; but as Tacitus found the Germans generally, and presumably the Saxons among them, a nation of farmers, tilling their village lands and pasturing their stock in the surrounding forests, it is probable that these invaders taught at least as much as they learned. At any rate they were a people of freeholders, as tillers of the soil, whereas the Roman farmers and labourers, excepting the Patricians in the period during which agriculture was fashionable among the highest in the State, were slaves or freedmen. It is true that under Roman law tenant right rose to a high degree of advantage as a security for a tenant farmer, whether a serf or a freedman; but the Saxons had the much more perfect security of ownership, either individually or in common. But the sword and the plough have been hereditary enemies from time immemorial, and the Saxons introduced and perpetuated war in this country, first against the Britons, and afterwards among their several tribes, who fought against each other for supremacy; and the legacy of almost constant warfare was the establishment of the feudal system, under which even those who were superior to the slaves by whom the lands of the Saxon settlers were tilled became mere retainers, protected by and subject to the thanes to whom great estates were granted for military services. As early as the time of Alfred the Great the system of fiefs had attained such ascendency that every man but the king was supposed to have his lord.

Peace under Canute, and later for a time under Harold, gave temporary revivals of prosperity; but the conquest of the country by William of Normandy soon followed, and the feudal system was thoroughly developed. What influence that system had upon agriculture can only be conjectured. That the position of the superior tillers of the soil was lowered when they became mere retainers of the Saxon thane or the Norman baron is obvious; but it does not follow that the system of farming deteriorated. According to high authorities, village communities at one time existed in England, and the manor, established by feudalism, is described as a survival of the ancient mark, while our commons are said to be relics of such communities. But communistic land tenure has not been remarkable for agricultural advancement, and it is probable that the cultivation of the soil may have been improved by the lords of manors, their bailiffs, and the so-called 'free tenants' or villains, who paid rents partly in kind and partly in services.

Mr. Green, in his Short History of the English People, traces the origin of the modern farmer class to the 12th century, by which time the lord of the manor had often found it more convenient and profitable to let on lease his estate, or at least his demesne, to tenants at rents payable in money or in kind, than to cultivate it on his own account. The term 'feorm', applied to the rent thus paid, is given as the derivative of 'farm' and 'farmer'. But while there is much in the writings of the old English chroniclers concerning the tenure of land, as to which, moreover, the Domesday Book gives much enlightenment, there is a tantalizing lack of information as to the manner in which the land was cultivated. According to Professor Rogers, in Six Centuries of Work and Wages, it was not until the middle of the 13th century that such information began to be recorded. Before that time, which he describes as 'the last ten or twelve years of the reign of Henry III', not a single farm account or manor roll was in existence, so far as his painstaking search enabled him to determine. Quite suddenly such documents became abundant, and they give a mass of information as to the grades of social life in villages, the sizes of holdings held by villains or free tenants and serfs, rents in kind and in service, and wages, and throw some light upon the practice of farming. As these documents represent nearly all the English counties, the information extracted from them by the laborious research of the author just named is more trustworthy than the statements of any single observer could be.

So far as the court rolls show, the practice of farming varied very little in different parts of the country. More than half the land was arable, the pasture being generally rough grazing ground held in common. All the varieties of grain and pulse cultivated at the present time were grown in the 13th and 14th centuries. As might be supposed, the several cereals were grown in different proportions, in accordance with the suitability of the soil and climate in various counties or districts. On some estates the proportion of wheat to the cropped area was over 40 per cent; but half the arable land was usually summer-fallowed every year. The plough commonly used was a wooden one, only the wearing parts being cased or tipped with iron. Both horses and oxen were used for draught purposes, four of either being worked on a plough. There is evidence of winter as well as spring barley being grown. As a rule, about two bushels of wheat, rye, beans, peas, and vetches were sown, and four of barley, bere, and oats. How the seed was covered is not certain, as these particular documents do not mention harrows, though they were in existence in some districts at least. Possibly much of it was ploughed in when it was sown broadcast, or hoed in when it was dibbled, as beans at least probably were. Nor is the land roller mentioned. There were no cultivated grasses or clovers, and root crops were not known.

Cattle, sheep, pigs, and poultry were commonly kept, and goats to a very small extent. The cattle were partly used for draught purposes, and partly for the production of meat, milk, butter, and cheese. Sheep for the most part were kept on the demesnes of the lords of the manors, until these gradually came to be let on lease to tenants. Commonly the demesne, the portion of a manor kept in the owner's hands, was about one-fourth of his estate, or from one-third to one-half of the arable land and the best of the pasture, and it was managed by a bailiff. Sheep were profitable, on account of the high price of wool. Live stock must have fared badly during the winter after a bad hay season, as the only considerable kinds of winter forage, apart from such corn as was used for horses and fattening animals, were hay and straw. Farcy and sheep scab are among the diseases mentioned in the records. The losses of live stock were very heavy.

The only manures used were farmyard manure, lime, chalk, and marl. Probably there was not enough farmyard manure for more than a small proportion of the large acreage of corn grown, and it must have been of very poor quality. Consequently, though partly owing to defective cultivation, the yields of crops were small. On the estates of Merton College, Oxford, which were in several counties, even in a good season wheat yielded only 8 to 16 bus. per acre, the latter quantity being extraordinary. For barley a common yield in such a season was 12 bus., rising to 24 bus. in an exceptional instance. For oats the range is wide, cases of 8 to 12 bus., one of 16, and one of 40 being named. From 6 to 12 bushels of beans and peas per acre appear to have been common yields. There is abundance of evidence as to the prices of corn, live stock, wool, and dairy produce; but, as the value of money was widely different from that of the present day, a comparison of them with current rates would be misleading.

All grades of tenants on a manor held and cultivated land—the free tenants, the villains, the cottagers, and the serfs. All but the first had to render services to their lord, varying in onerousness in accordance with their respective grades. In course of time all the villains became free tenants, while the men of lower rank became free labourers. It would be out of place in this article to trace the progress and causes of the emancipation, which was a very slow one, servitude having been still in existence in the latter part of the 15th century.

It is probable that agriculture improved to some extent as leases to tenants became common. This change appears to have been introduced in the 13th century by municipalities who owned estates, and the practice was soon followed by individual proprietors who found farming unprofitable or irksome. The movement began in Scotland, apparently, at about the same time as in England; for Mr. Wilson, in British Farming, says that Scottish leases of the 13th century are still in existence. The process was greatly hastened by the enormous reduction of the population by the ravages of the plague known as the 'Black Death', in 1348, by which, it is stated, the number of people in England was reduced by one-half. Labour then became so scarce, and the wages of free labourers so high, that landlords were glad to get rid of their demesnes. The notorious Statute of Labourers, enacted in 1349, requiring every man or woman, bond or free, able to work and not having land sufficient for maintenance, to serve any employer needing his or her services at the wages current before the plague occurred, failed entirely, and a modification of it passed in 1350 did not avail to make labour plentiful. This scarcity of labour led to the massing of small holdings into large sheep farms, a change found profitable in consequence of the high price of wool. But vagrancy was so seriously increased by this change that, in the time of Henry VII, an Act was passed to compel owners of estates to keep up the buildings on every farm that, within the preceding three years, had contained not less than twenty acres. Although this law, enforced with heavy penalties, had some effect, the aggregation of holdings was not stopped, and the passing of further statutes was unavailing to prevent the increase of sheep-farming.

Only one treatise on agriculture is known to have been written in the 13th century, namely, La Dite de Hosbanderye, an essay in Norman French by Walter de Henley. According to Professor Rogers, this was not superseded until Fitzherbert's work made its appearance, in the 16th century.

One of the greatest hindrances to agricultural improvement was the communal system of holding some of the land, under which each tenant on a manor had a certain number of furrows of the arable land, separated by balks of unploughed land. One tenant often had several strips of land in different parts of the common field. After harvest the land was grazed in common by the tenants. Vestiges of this common-field system prevail even at the present time, although they are few in number. Some rudimentary attempts to drain wet land were made; but the common practice for the purpose of preventing crops from being injured by excessive wetness in the soil was that of ploughing the fields in high-backed 'lands', miscalled 'ridges' by some writers. The remains of these 'stetches' are to be seen in many parts of England, as in the South Downs for example. The disadvantages of the common farming system had been recognized in the 13th century, as indicated by the passing, in 1236, of the Statute of Merton, under which lords of manors were empowered to enclose commons on which the common rights of freeholders had been granted by them; and half a century later the Statute of Westminster extended this right to commons without the limitation just mentioned. When Sir Anthony Fitzherbert wrote his Boke of Husbandrie in the early part of the 16th century, he said that most of the lords of manors had enclosed the portions of their demesne lands which were in the common fields. Fitzherbert, as a practical agriculturist, was strongly in favour of enclosure, as were other agricultural writers who succeeded him. He urged the tenants to assist in the process of converting common lands into separate holdings, and this was soon generally recognized as advantageous to the more substantial tenants; but some of the smaller tenants, through the curtailment of their rights of pasturage, and the labourers who had not long been freed from serfdom, suffered from the change. Desirable though the change was in the interests of agriculture, there is no doubt that much wrong was done to the poorer portion of the rural population by the high-handed manner in which enclosure was frequently carried on.

The loss of common rights in land, as matters turned out, was mitigated by the great increase of employment, and consequently of wages, which accompanied and followed the enclosures. Professor Rogers describes the 15th century and the first quarter of the 16th as 'the golden age of the English labourer', considering the wages he earned in connection with the prices of the necessaries of life. But the process of aggregating small holdings and converting arable farms into sheepruns, already alluded to, made great progress in this period. The price of wool was very high, and sheep-farming paid handsomely. Statute after statute followed the one passed in the reign of Henry VII, already mentioned, for the purpose of checking the conversion of arable land to pasture. But the process continued all through the reigns of Henry VIII and several of his successors, greatly to the disadvantage of small farmers, whose holdings were often taken from them by fraud or force. Rents rose enormously, and wages fell, and in the reigns of Edward VI and Mary further laws were passed to enforce a return to arable farming; but it was not until the time of Elizabeth, when the growth of wealth and industry throughout the country had begun to render tillage crops more profitable, that a reaction in favour of arable farming set in. Still, Elizabeth, like her predecessors, deemed it desirable to take measures for the conversion of sheepwalks to arable farms. Moreover, whereas in the reigns of some previous sovereigns laws had been passed to fix men to their native parishes, and to force them to work for wages lower than those which the natural working of supply and demand would have secured to them, Elizabeth protected them by adjusting wages upon a sliding scale in proportion to the price of flour; while, to attach the peasantry to the rural districts, she provided allotments for cottagers. To keep the poor from destitution the noted Poor Laws of her reign were enacted.

That farming was prosperous in the reign of Elizabeth is shown by the improvement of farmhouses and records indicating an advanced state of living among farmers. The low condition of the labourers was the result of the extension of sheep farming which had been so long in progress. That the Poor Law of the forty-third year of the queen's reign was beneficial in the first instance there appears to be no doubt, although abuses soon crept into its administration.

Except for the essay of Walter de Henley, agricultural literature had its foundation in the time of the Tudors, as pointed out by Mr. R. E. Prothero in Pioneers and Progress of English Farming. Fitzherbert (see art. FITZHERBERT) wrote in the time of Henry VIII, in 1523, and Thomas Tusser in the reigns of Mary and Elizabeth, and Scot and Sir Hugh Platt in the time of Elizabeth. Hops had been introduced into England in the time of Henry VIII, and Scot's work was A Perfite Platforme of a Hoppe Garden.

Tusser (see art. TUSSER) in his quaint treatise mentions turnips, introduced from Flanders, where agriculture was more advanced than in this country, but only as a kitchen-garden crop. His Five Hundredth Points of Good Husbandry, published in 1573, a second and enlarged edition of A Hundredth Good Pointes of Husbandrie, published in 1557, is a calendar of farming operations and instructions for each month of the year, written in verse. As on his title page the author states that it directs 'what corn, grass, &c., is proper to be sown', it might be supposed that so-called 'artificial grasses' had come into use; but there is no mention of such grasses or of clovers in the body of the work. He writes of 'quicke' sets for making fences, and gives instructions for selecting hop poles when cutting down wood. Cattle, it appears, were fed partly upon the lopping of trees, though it is curious to notice that this lopping is mentioned as an operation for January, when the boughs would be leafless. Fed on only hay, straw, and such extras as boughs, it is no wonder that 'From Christmas til May be wel entered in, some cattel wax faint and looke poorely and thin'. It is curious to notice that Tusser recommends the sowing of oats as early as January. Beans, peas, and tares he directs to be sown in February; but winter tares had not been introduced in his time. The ploughing-in of beans and the harrowing of the land afterwards are mentioned; but beans were probably sometimes dibbled. Meadows for hay, Tusser says, should be shut up in February and dunged. The planting of hops in March is recommended, and there are instructions for making the mounds in which the sets were to be planted. Grafting is another March work noticed. Barley, it appears, was sown in March, April, and May, and Tusser gives bad advice as to sowing the heaviest land first. On the other hand, he is sound in his insistence on the necessity of harrowing barley land 'as finely as dust'. Wheat and rye were ploughed in; but barley and oats, Tusser indicates, should be sown on the land after the second ploughing, and harrowed in. The land roller was in use, as the rolling of wheat in March, when the soil is dry, is suggested. Tusser was a strong advocate of good gardening, and his calendar of operations shows that most of the kitchen-garden crops of our own time were grown in the 16th century. His experience was gained in Suffolk and Essex, and his advice as to sowing beetroot in March and cucumbers in the open ground in April seems to indicate that the springs of his day were warmer than they are now. He advocated the beginning of summer-fallowing in April. Suffolk and Essex were noted in his time for butter making, and the care of cows is dwelt upon. But Suffolk cheese, even then, had acquired an unfavourable reputation, as it was made from skimmed milk. Ewes were milked in Tusser's time, and their milk was used partly, generally mixed with cows' milk, for the making of cheese. Scalded cream and butter therefrom were apparently made in Devonshire in the 16th century. The hand-weeding of corn crops is named as one of the principal operations for May. The washing and shearing of sheep stand first in the calendar for June, and haymaking is another operation named for that month. 'Tumbrels', or tipcarts, are mentioned. Tusser complains that some farmers have not barn-room enough for their corn crops, and that ricks have to be made in the fields. Apparently pigs' courts were uncommon, as he mentions the comfort which a hog finds in winter in a cart-shed recommended primarily for preserving vehicles. Haymaking was continued in July, and flax was then harvested. A long disquisition in favour of enclosure, and in disparagement of 'champion' or open-field land fills much of the space devoted to July. The third ploughing of the summer-fallowing was to be finished in July, and then 'striking' the land was recommended in August. Harvest was in August, wheat being cut with the sickle, and barley mown with the scythe. Barley was sometimes bound in sheaves, and sometimes raked into heaps to be carted loose. September and October were the months for sowing winter wheat.

Mr. Prothero gives a list of the agricultural writers of the 16th, 17th, and first half of the 18th centuries, with the dates of the editions of their works which he has seen, but states that the dates affixed are not all those of the first editions. Leonard Moscall's book on The Government of Cattel, in three parts, on oxen, horses, and sheep respectively, is dated 1605. Norden, Vaugham, and Markham quickly followed. Vaugham's book was the first English work on water meadows and irrigation generally.

Apparently farming paid well in the reign of Charles I, as there was a great advance in rents. Fresh land was brought into cultivation, and a scheme for reclaiming the fens was set on foot. Walter Blith (see art. BLITH), one of the best known of the early writers on English agriculture, wrote The English Improver in that reign, and published it in the last year of Charles and the first of the Commonwealth. The second edition, published in 1653, was entitled The English Improver Improved, or the Survey of Husbandry Surveyed, and was dedicated to 'The Right Honorable the Lord General Cromwell, and the Right Honorable the Lord President, and the rest of that most Honorable Society of the Council of State'. In it the author gave the rents of three classes of land, those of the worst class being 1*s.* to 10*s.* per acre; those of the middle class, 10*s.* to 20*s.*; and those of the richest land, 20*s.* to 40*s.* Considering the great purchasing power of money in those times, these rents must be regarded as high. He stated that some tenants had doubled the value of their farms, and complained that such men had simply thus occasioned 'a greater rack' upon themselves in rents. He was probably the first writer to advocate tenant right by legislation, and he appealed to the Protector and the Council of State to grant it. He represented too great a trust in frequent ploughings and the disposition of farmers to take more land than they could farm properly as faults characteristic of the farming of his time. Blith was a strong advocate of land draining, on which he wrote with great judgment. In 1650 Sir Richard Weston published A Discourse of Husbandrie used in Brabant and Flanders, which Mr. Prothero says was the first attempt to explain in this country the cultivation of turnips as a field crop. Samuel Hartlib, who edited Weston's book, published one a year later entitled Samuel Hartlib his Legacie, or an Enlargement of the Discourse of Husbandry; and afterwards he brought out a treatise recommending the general planting of fruit trees and his Compleat Husbandman. He gave testimony of the improvement of farming, including the purchase of town manure and the common use of lime in some counties. Agriculture was much more advanced in Flanders at the period than in this country, and Hartlib recommended the adoption of the practice of the former country in growing roots and folding them on the land with sheep, as well as the growth of clover, lucerne, and sainfoin. To Sir Richard Weston Mr. Prothero gives the credit of first growing turnips and clover as field crops in England. But it was many years before his example was commonly followed. The drainage of the fens made considerable progress during the latter half of the 17th century. It had been begun by the Romans; but the works had fallen out of repair. Dutchmen, who had had prolonged experience of drainage work in their own country, were employed to a large extent to carry it out in England.

Agriculture in Scotland in the 17th century was more backward than it was in England. There were the same common fields, in which tenants held scattered strips of land. Alexander Garden, of Troup, is quoted by Mr. Prothero as describing the system pursued in 1686 as one in which the land was divided into infield and out-field, the former being kept constantly under corn crops, manured every third year, and the latter allowed to grow weeds and natural grasses for four or five years, after which it was ploughed twice, and sown with corn. Donaldson, who wrote Husbandry Anatomised, in 1697 described the agriculture of Scotland in very disparaging terms. As late as 1716, Sir Archibald Grant, of Monymusk, Aberdeenshire, says that field crops of turnips grown by the Earl of Rothes and a few others were objects of wonder.

A great change took place in England and Scotland in the 18th century. The great expansion of our manufacturing industry, the rapid increase of population, the extensive enclosure of waste land, and advanced prices of farm produce, strongly stimulated improvement in farming. To what extent, if at all, the frequently changed fiscal laws prohibiting the imports or exports of corn under specified stipulations as to prices, giving bounties on exports, and imposing duties on exports, helped or hindered the improvement it would be difficult to determine, as the several regulations were antagonistic in their influences. It is certain that, by itself, the prohibition of exports when prices were above a specified range checked production; but it is not certain that the prohibition of imports, or the imposition of duties, when prices were below specified rates stimulated production so long as there was a liability to produce more than the nation's consumption in any good season.

Jethro Tull (see art. TULL), who published his Horse-Hoeing Husbandry in 1733, was one of the numerous agricultural teachers of the century; and, although his idea that the stirring and aeration of the soil and the destruction of weeds would suffice to ensure continuous productiveness without manuring was a mistaken one, his advocacy of his method and the results which he produced by it did much to inculcate one of the most important essentials of good farming. Tull was also an advocate of the drilling of corn and seeds, a system which he introduced from Lombardy, and of the cultivation of turnips. His teachings and example were followed on a large scale by a few landowners in England and Scotland. One of the first of these was Viscount Townshend (see art. TOWNSHEND), known as 'Turnip Townshend', who was the founder of the Norfolk four-course system of turnips, spring corn, clover, and wheat. The improvement which Lord Townshend effected on his poor and light land in Norfolk astonished his contemporaries. His agricultural career began in 1730, when he gave up politics for farming.

That the comparatively enlightened agricultural system advocated by Tull and practised by him, by Lord Townshend, and a few other English landowners, had penetrated to Scotland is clear from the records of The Honourable the Society of Improvers in the Knowledge of Agriculture in Scotland, established in 1723. The members, over three hundred in number, included many of the most eminent Scotsmen of the period. The society appears to have been somewhat of the character of an unofficial Board of Agriculture, in so far as its main objects included the collection and dissemination of information. In reply to an enquirer as to the best method of improving some land, the Society recommended more frequent manuring than had been practised, the ploughing-in of a pulse crop, occasional summer-fallowing, and the drilling and horsehoeing of turnips, to be followed by folding them off for sheep feeding.

Early in the century the farmers of Essex and Suffolk had begun to drain fields closely, filling the drains with bushes or stones, and they also dressed their lands with the phosphatic crag, probably containing coprolites, which was dug up in certain parts of their counties. But the agriculture of the eastern counties had long been ahead of that of almost all other parts of the country, and the century was nearly ended before the improved methods had been adopted commonly throughout the greater part of England.

In the course of the 18th century most of our modern breeds of cattle and sheep were more or less improved by the best breeders. The Longhorn cattle were improved by Bakewell (see art. BAKEWELL), the Shorthorns by Sir John and Sir James Pennyman and more notably by the Collings family later on, the Herefords by Benjamin Tompkins, the Sussex by Ellman, and the Devons by Francis Quartley. History is defective as to the early improvement of those ancient breeds, the West Highlanders and the Galloways, and the development of the Aberdeen-Angus cattle was of later date than the period under notice. Bakewell had created the new Leicester breed of sheep, and Ellman of Glynde had improved the Southdown. In 1798 the Smithfield Club was founded, and its influence upon the improvement of stock breeding soon became noticeable.

The association just named was not the first of the bodies which have done so much to improve agriculture to be established. The Bath and West of England Society was founded in 1777, the Edinburgh Society for Encouraging Arts, Sciences, Manufactures, and Agriculture in 1755, and the Highland Society in 1784. In the History of the Highland and Agricultural Society of Scotland, by Alexander Ramsay, many interesting details as to the condition of agriculture in Scotland in the 18th century are quoted from a statistical work and official surveys made in the latter part of the period. One of the notes is to the effect that in Berwickshire, 'the cradle of Scottish husbandry', improvements were begun about 1730 by Mr. Swinton of Swinton and Mr. Hume of Eccles. The Earl of Stair is believed to have been the introducer of the turnip crop into Scotland, but Lord Kames (see art. KAMES) first grew them on a large scale for cattle feeding about 1745. In Roxburghshire they were grown in drills in 1747 by Dr. John Rutherford, but the general substitution of the system of drill cultivation of the turnip for the practice of broadcasting was chiefly brought about, according to Loudon, by the example and exertions of Mr. Dawson (see art. DAWSON) of Frogden, in Berwickshire, who also falls to be credited with the introduction of the practice of ploughing with two horses abreast, and also of the alternate system of husbandry. These important improvements date from the year 1763. Cultivated grasses and clovers had, however, been grown by Lord Kames as early as the year 1750. The common use of a two-horse plough in Berwickshire before 1776 is a striking sign of agricultural advancement, though oxen as draught animals had not been discarded. The cattle consisted mainly of Longhorns and Shorthorns, and the sheep of the new Leicesters in the lowlands and a small black-faced breed kept in the hill districts. In other counties the breeds of cattle and sheep varied. In Ayrshire, in the last decade of the century, potatoes had become a generally established crop. In Midlothian they are said to have been introduced as a field crop in 1744. Threshing machines, worked by horses, were general in Midlothian in 1793. These are only a few of the notes which indicate the progress that had been made in Scottish farming in the 18th century.

The last quarter of the century covered the most active period of the career of Arthur Young (see art. YOUNG), who did more than any other man before, during, or after his time to extend the knowledge of the best methods of agriculture in his own and other countries, although, like Tusser and some other famous writers on the subject, he failed lamentably in farming on his own account. This is not the place in which to give an account of his tours and his public work. In 1793 the old Board of Agriculture was established, with Sir John Sinclair (see art. SINCLAIR) as president and Arthur Young as secretary. The chief work done by this body was the appointment of writers to survey the several counties, or many of them, and the publication of their reports, which differ widely in merit, but are full of information of farming details. Young was a strong advocate of the enclosure of common lands, although he lamented the abuses which were connected with the practice.

Contemporary with Young was the famous Mr. Coke (see art. COKE) of Holkham, afterwards Earl of Leicester, who made farming on a large scale a great success under very unfavourable circumstances, much of his estate, including the portion of it which he farmed, being sandy and in miserably low condition. He was one of the first farmers to use bones as manure, and he is credited with having introduced the use of oilcake and other artificial foods for stock. By the purchase of manure, stall-feeding of cattle, sheepfolding on turnips, and other means, he raised the fertility of his land to a high pitch, and his example and precepts were followed by his tenants, for whom he erected improved buildings and to whom he granted long leases. He also did much to improve the breeding of Devon cattle and Southdown sheep. His annual sheep-shearings, attended by visitors from various parts of this and some other countries, through the inspection of his estate and the discussions held, did much to spread enlightened views as to farming. His example in holding these meetings was followed by a few other landlords. Agriculture in the time of Young and Coke excited keen interest among the leading men in the country. King George III was a notable farmer, and many noblemen followed his example.

In the latter half of the 18th century the enclosure of lands made great progress. During the reign of George III, from 1760 to 1820, an immense number of enclosure Acts were passed, by which 3,500,000 acres of land were brought into improved cultivation. One writer makes the area much greater. The first general enclosure Act, passed in 1801, greatly accelerated the process. The high prices of corn and other farm produce in the latter part of the 18th century led to the reversal of the system of converting arable land into pasture, which had been the trouble for a very long period. Another result was the rapid increase of the farm tenancy system, as small freeholders sold their land in order that they might obtain higher interest on their capital by hiring large farms. In the last quarter of the 17th century, according to Macaulay, the freeholders exceeded the tenants in number; whereas, by the middle of the 19th century the former had almost disappeared, except in a few counties. Thus, in the period of agricultural prosperity and rapid land enclosure, noticed above, the farmers to a large extent became tenants, and the labourers landless. Moreover, in England, land, in early times let on lease, came more commonly under the system of yearly tenancy, without any security to tenants for their improvements. Adam Smith, who published his Wealth of Nations in 1776, when small freeholders were still numerous in England, expressed much regret at their threatened extinction, partly because of the political subserviency which he anticipated as the result. He expressed the fear that the extension of the franchise to the leaseholders of Scotland, who had no votes when he wrote, would lead to the discontinuance of leases in that country; but this fear was not realized. Smith also wrote strongly against the vexatious restrictions common in leases and other farm agreements of his time.

Although farming was generally prosperous in Young's time, it was a highly speculative business. In his Annals of Agriculture he records tremendous fluctuations in prices, especially those of wheat. Thus, in 1784 wheat was selling at 40*s.* 4*d.* per quarter, and the price remained low until 1792, when a rise set in, leading up to 75*s.* in the spring of 1795, and to 112*s.* in the last month of the same year. But in 1796 there was a fall to 62*s.* 4*d.*, and in 1798 to 50*s.*; whereas, in October, 1800, the London average was 127*s.* 8*d.* In February, 1801, there was an advance to 164*s.* in some country markets, while in October the price had dropped to 78*s.*

As to farm rents, some of the county reports prepared for the Board of Agriculture show that they had risen enormously. For example, a tabular statement for the county of Somerset makes the advance for the forty years ended with 1795 from £1, 5*s.* to £3, 10*s.* per acre for land of the best quality, and from 2*s.* 6*d.* to 10*s.* for that of the poorest class.

But while landlords obviously obtained a greater share than tenants of the wealth arising from agricultural prosperity, the farm labourers fared worst of all. Young's Annals are full of plans for 'the management of the poor'. In 1784 the general range of farm labourers' wages was 1*s.* 2*d.* to 1*s.* 6*d.* per day, and the price of the quartern loaf was 7½*d.* In 1795 the price was 12¼d., and wages had not by any means increased proportionately. So far, indeed, was this from being the case, that special measures in that year were deemed necessary to save the men and their families from destitution. The magistrates of several counties issued tables indicating the wages which every man ought to be paid, in proportion to the number of his family and the price of bread, and instructing parish officers to make up the difference between this rate and that paid by his employer. This bad system was kept up until the Poor Law Amendment Act was passed, sadly to the demoralization of the labourers, who, under it, were made permanent paupers.

Nothing is more striking to the reader of reports on the farming of the latter part of the 18th century than statements showing that, in many respects, the industry had advanced nearly up to the level of present-day practices, at least in the hands of its most enlightened managers. The course of cropping had become much as it is now, or rather as it was before agricultural depression drove the pulse crops largely out of cultivation, and led to the expansion of temporary and permanent pasture. Even the labour-saving implements and machines now in use, or introduced in recent times only to be discarded, were to some extent anticipated by those which were brought out in Young's time. Jethro Tull's drill was one of his own invention, and it was superseded in Young's day by several others of different construction. The Suffolk corn drill with its seed-cups and cutting coulters was in use, as it still is in a slightly improved form, while an Essex drill, of which Young gave a drawing, had coulters of the shape re-introduced from the United States as a novelty a few years ago. The Northumberland drill sowed lime, ashes, or soot with turnip seed. As to ploughs, although there has been a vast improvement in them during the last twenty years, the turnwrest plough still used largely in Kent and Sussex, and in an improved form elsewhere, was in common use, and no implement of the kind does better work except when it is desired to produce a broken furrow slice, though its draught is too heavy for two horses. Two-furrow ploughs, brought into notice as novelties some years ago, were found by Young in several counties, and before 1770 Mr. Ducket, of Petersham, invented a three-furrow plough, with which he turned over from 3 to 4 acres in a day, using four or five horses. Another of Ducket's ploughs closely resembled an American implement not long ago brought into this country, for use in ploughing up old or temporary pasture. As early as 1780 a reaping machine was invented by Mr. Lofft, of Bury St. Edmunds, but was not much used. Horserakes and chaff-cutters were introduced before 1800, and some of the harrows and land rollers of the period under notice are still in use.

It was chiefly in relation to the comparative inferiority of live stock, the insufficiency of fattening cattle, sheep, and pigs with the help of purchased feeding-stuffs, and the lack of artificial manures, that the agriculture of the end of the eighteenth century fell short of the efficiency attained at a later period. Even in Essex, which Young regarded as better farmed than any other English county, the average yield of wheat in 1794 was put at only 24½ bushels per acre, and that is the highest average given in any of the county surveys of the period. For Suffolk, another well-farmed county, Young, in 1797, estimated the averages at 22 bus. for wheat, 28 for barley, and 32 to 34 for oats. All these averages are much lower than those of the present time in the two counties. The only breed of farm horses that had been greatly improved was the Suffolk Punch, though the heavy and hairy-legged animals of Lincolnshire and some of the Midland counties, the progenitors of the Shire breed, had also a high reputation. As already noticed, the improvement of some breeds of cattle and sheep had begun; but very little attention had been given to pigs, though the Berkshires were well known, and the Suffolk Whites and the Essex Blacks were praised by Young.

The 19th century was the first in which science was systematically applied to agriculture. Sir Humphry Davy (see art. Davy), the father of English agricultural chemistry, did not publish his Elements of that division of science until 1813, while Boussingault (see art. Boussingault), who held a like position as the introducer of the branch in France, was a boy of eleven years at that time, and Liebig (see art. Liebig), the great German chemist, was a year younger. The only manures commonly used before the 19th century were farmyard and town manure, night-soil, marl, lime, chalk, soot, whale-blubber, fish, and malt dust, bones and rape dust having been applied to land by only a small minority of advanced farmers. There were years to wait, when the century began, before any considerable addition to this list could be made.

The period began just after the third of a series of three bad harvests; but farmers, protected by high import duties, made handsome returns from prices raised enormously by war in Europe and an inflated currency. Wheat had averaged 113*s.* 10*d.* per quarter in 1800, barley 59*s.* 10*d.*, and oats 39*s.* 4*d.*, while the corresponding prices of 1801 were 119*s.* 6*d.*, 68*s.* 6*d.*, and 37*s.* Although war was almost constantly raging on the Continent until 1815, the prices of corn fluctuated greatly. For example, wheat fell from 119*s.* 6*d.* in 1801 to 69*s.* 10*d.* in 1802, and 58*s.* 10*d.* in 1803, other corn falling correspondingly. The last price given, however, was the lowest yearly average in a period of 22 years, beginning in 1799, and in 1812 it was no less than 126*s.* 6*d.*, while barley stood at 66*s.* 9*d.*, and oats at 44*s.* 6*d.* These were the highest annual averages ever realized for wheat and oats, while that of barley had only once been higher. While war lasted farmers made fortunes; but rents and poor rates rose enormously, and farmers' scale of living likewise. The rental of the Northumberland agricultural estates of Greenwich Hospital rose from £6950 in 1793–4 to £15,560 in 1814-5, an advance of 124 per cent; and that of agricultural land in Scotland, according to Wilson's British Farming, advanced from £2,000,000 in 1795 to £5,278,685 in 1815. As to rates, in England and Wales there was a rise from £5,848,000 in 1803 to £8,164,000 in 1815.

Until nearly the end of the 18th century, farming had been more backward in Scotland than in England; but these positions were reversed before the end of the second decade of the succeeding century. Mr. Wilson cited the increase of the agricultural rental of Scotland, quoted above, as evidence of the rapid progress of Scottish husbandry, which he attributed to leases, the superior education given in Scottish parish schools, the high prices of farm produce, and the unlimited issue of paper money, which enabled bankers to make large advances to landlords and tenants for purposes of improvement.

After peace was declared at the end of the Napoleonic wars, in 1815, a period of agricultural distress set in, a great fall in prices having taken place, while the harvests of 1816 and 1817 were bad ones. Later on, in 1821, the resumption of cash payments heightened the distress. It seems strange that farmers should have been brought to a state of severe depression when the prices of corn, notwithstanding the fall, averaged nearly double as much as those with which we have been familiar for more than twenty years, taking the prices of the three chief cereals together. The ranges of yearly averages from 1815 to 1821 inclusive were 56*s.* 1*d.* to 96*s.* 11*d.* per quarter for wheat, 26*s.* to 53*s.* 10*d.* for barley, and 19*s.* 6*d.* to 32*s.* 5*d.* for oats. But all engagements had been made on the basis of inflated prices, and the scale of living had also been based upon them. At any rate, evidence of the beginning of depression was brought before the Committee on the Corn Laws in 1814, and in 1816 the Board of Agriculture deemed the state of affairs serious enough to render an enquiry into the condition of agriculture imperative. The evidence collected showed that there had been a fall of £9,000,000 in the rental of agricultural land in England and Wales, while landlords had lost great sums through the bankruptcy of farmers, and had had a great number of farms thrown on their hands. Not a few among the landlords who had encumbered their estates with mortgages and heavy annuities, and had maintained an extravagant style of living, were unable to meet their liabilities. Distress among the farm labourers became worse than ever, and riots and incendiary fires were common in many districts.

The depression became worse after 1820, and in that year and four other years ending with 1836 Select Committees sat to enquire into the disastrous condition of agriculture. Rents and tithes were unpaid to a great extent, and foreclosures by mortgagees on small estates were common, while there were numerous failures of banks and tradesmen. Rates touched 20*s.* in the pound of assessment in some parishes. Alteration after alteration was made in the corn duties, but without avail, and, although there were fluctuations in the fortunes of agriculture, no sustained relief took place until the new Poor Law of 1834 and the commutation of tithes in 1836 had begun to work. During the long period of depression the yeomen of England became almost extinct.

Enough has been stated on this subject to show that the improvements in agriculture which took place in the first third of the century were carried out in spite of adverse circumstances. On the whole, indeed, the condition of the agricultural land, in England at least, deteriorated during the period; and yet the march of invention was not entirely stayed. The Board of Agriculture lingered on, in spite of lack of funds, until 1822. One of the greatest benefits which the Board conferred upon agriculture was the engagement of Professor (afterwards Sir Humphry) Davy to deliver annual lectures on agricultural chemistry, which he did from 1803 to 1813 inclusive.

In mechanical invention one of the most important events during the period of distress was the introduction in Scotland, in 1828, of Bell's reaping machine, the first to command any considerable degree of success. The improved machines based upon it were much more extensively used. At about the same time, or a year or two later, Mr. James Smith, of Deanston, brought into practice his parallel system of land draining, for which stones were used at first, but cylindrical tiles later. The first machine for making these tiles was invented by the Marquis of Tweeddale, who was awarded a medal for it at the Perth Show of the Highland Society in 1836. This Society had offered premiums for corn of improved quality as early as 1816, for improving the breeds of horses in the same year, and for sheep in 1819. The first show of the Society was held in 1822. In 1829 Peter Elder, of Perth, exhibited at the show of the Society a model of a steam traction-engine, which apparently remained only a model for some time, as many years elapsed before such engines came into use.

The live-stock industry suffered less than arable farming for corn growing during the period of depression, and great progress was made in the improvement of breeding. The Booths and Sir Charles Knightley were developing the Shorthorn; John Price and other breeders were improving the Hereford; Francis Quartley and Mr. Coke, afterwards Earl of Leicester, were continuing the work with the Devon; and the improvement in Scottish breeds of cattle, sheep, and horses was made manifest at the Highland Society's shows. Pigs, too, had begun to obtain their share of the attention of improving breeders.

After 1836, when agricultural recovery set in, leading up, in spite of brief reverses, to nearly forty years of the greatest farming prosperity of the century, the march of improvement and enterprise was very rapid. In 1838 the Royal Agricultural Society was founded, holding its first show in the following year, and its exhibitions, with those of kindred societies, greatly encouraged the improved breeding of live stock and mechanical invention. In addition to some of the improvers of stock already mentioned, who were still living, many others too numerous to mention engaged in the good work. In 1842 Hugh Watson and William M'Combie exhibited some of their improved Aberdeen-Angus cattle at the Highland Show, while Clydesdale horses had been sufficiently developed to be favourably noticed in the official report of the show in 1850.

Agricultural chemistry made great strides, and began to give practical results. In 1839 Liebig published his important work on Chemistry in its Application to Agriculture and Physiology, while Boussingault at about the same time was devoting his great chemical knowledge to the benefit of agriculture in France. In 1842 Mr. John Lawes (see art. LAWES), afterwards Sir John, took out a patent for the manufacture of artificial manures from mineral or fossil phosphates, and in the following year he established a factory for the making of superphosphate, while in the latter year he also began his famous experiments. The importation of guano had been in progress for some years before, at first on a small scale, but afterwards in steadily increasing quantity; while nitrate of soda came into small use in 1850.

To Ireland belongs the credit of having first started agricultural education upon a popular scale, the Glasnevin Institution for the training of primary school teachers in the principles of agriculture having been founded in 1838. To make this statement is not to ignore the foundation of the Chair of Rural Economy in Edinburgh University in 1790. It appears that the distress caused by the Irish famine in 1846–7 delayed the development of the Glasnevin scheme; for it was not until after that catastrophe that agricultural classes were established in the elementary schools of Ireland. The experiment was not a success, as the parents of the pupils at that time were too ignorant to appreciate the advantages offered, or too poor to spare their boys and girls from farm work. Glasnevin was reorganized in 1852, when new buildings were erected, and a model farm was attached to the Institution, named after Prince Albert, who showed much interest in the undertaking. The Royal Agricultural College at Cirencester was established in 1845, and the chemical department of the Highland Society in 1849. Farmers' clubs, which flourished greatly in those times, did much to bring the results of agricultural teaching home to the farmers of the country. The Chambers of Agriculture were of much later foundation.

The Corn Laws were repealed in 1846, and although a poor harvest in 1847 caused a rise in the price of wheat instead of the great fall expected, the fall after 1848 was a heavy one, and in 1851 the average was only 38*s.* 6*d.* per qr., by far the lowest price of the century up to that time. One of the temporary reverses alluded to above occurred in 1848–51, and it gave rise to Caird's (see art. CAIRD) tour, in which he followed to a great extent the course taken by Arthur Young at different periods of that famous man's career. The comparisons which Caird made between the agricultural conditions of Young's time and his own are very interesting. While he noticed great improvements, he found much very poor farming. He estimated the rise of rent in England between 1770 and 1850 at 100 per cent, that of the wages of farm labourers at 34 per cent, and that of the yield of wheat at 15 per cent. But the wages of the men were miserably low nevertheless. The ordinary weekly wages in money of day labourers ranged from a pitiful 7*s.* in parts of the south, east, and west of England up to 13*s.* 6*d.* as the maximum in Lancashire. These calculations did not cover beer, given commonly in some counties, or the numerous extras obtained at piecework and in the hay and corn harvests, which in some of the lowest wages counties would have raised the average by about 2*s.* a week. Caird's estimate of the area under crops, fallow, and cultivated grass in England in 1850 was 27,000,000 ac., which was certainly much over the mark, as sixteen years later, when the Agricultural Returns were first issued, the total for England was put at 22,236,737 ac.; and even if Caird included Wales, of which there is no indication in his remarks, the addition would be only 2,284,674 ac. The average yield of wheat in England on 3,416,750 ac., as reckoned by Caird, he estimated at 26½ bus. per ac., and the total production, in round figures, at 11,318,000 qr., or about 2,000,000 less than Young's obviously extravagant reckoning in 1770. A great acreage of grass land had been broken up for wheat between the two dates, and there is no doubt that the yield per acre had increased. Young's early estimate appears all the more extravagant when it is considered on the basis of the first official return of 3,126,431 ac. under wheat in England.

Land draining with tiles had not extended very widely, although Smith's (of Deanston) new system, improved by Parkes, was carried out by some enterprising landowners. Soon after Caird wrote, however, a great amount of draining was done. He found fixed steam-power threshing-machines in a few places, but no steam ploughs or cultivators. Before his tour had ended John Usher, of Edinburgh, had brought out a rotary cultivator worked by steam power; but probably it was not much used. The use of nitrate of soda was noticed by Caird as a novelty in 1850. He made a strong appeal for the official collection of agricultural statistics; but it was not until 1866 that the Agricultural Returns of Great Britain were first issued. In Ireland similar returns had been collected by the constabulary for some years before that date, and from 1853 to 1857 they were obtained by the Highland Society for the Board of Trade.

By the time that Caird's book was published the depression had almost ended, and 1853 was the beginning of one of the most prosperous periods which agriculture in this country has ever known. The discovery of gold in California in 1848 and in Australia in 1850 had begun to tell by the end of 1852 in a very favourable manner upon commerce and agriculture alike, as prices rose rapidly. Wheat had averaged only 38*s.* 6*d.* per. qr. in 1851, the lowest price returned up to that time since the corn averages were first collected in 1790, and in 1852 the average was only 40*s.* 9*d.* But in 1853 there was an advance to 53*s.* 3*d.*, and other kinds of corn rose considerably. A deficient harvest helped the advance, although the home deficiency of wheat was met by an importation of over 6,000,000 qr., including flour, the greatest quantity up to that time. The Russian war sent the price of wheat up to 72*s.* 5*d.* in 1854 and to 74*s.* 8*d.* in 1855, and many farmers made fortunes, as other kinds of corn were proportionately dear, and the harvest of 1854 was a splendid one. There was a considerable drop after 1855; but the Indian Mutiny in 1857 kept the decrease in wheat within moderate bounds, while barley rose in value, and oats made good prices. According to Lawes, the wheat area of the United Kingdom in 1854 was a little over 4,000,000 ac., and he estimated the produce at over 17,563,000 qr., probably the greatest quantity grown up to that time, and a total only once afterwards exceeded. A magnificent harvest in 1857 was followed by a very good one in 1858, and the average price of wheat fell to 44*s.* 2*d.* per qr., while a fair one in the following year reduced it to 43*s.* 9*d.*; but barley and oats were not reduced proportionately, and the great yields left good returns. A bad harvest in 1860 caused a sudden recovery of nearly 10*s.* in the price of wheat, and the American Civil war helped towards a further advance in 1861 and 1862: but the greatest wheat crop on record in 1863, when Lawes's estimate was 17,922,000 qr., brought the average of 55*s.* 5*d.* recorded in 1862 down to 44*s.* 9*d.* The prices of meat and dairy produce, however, rose when corn declined in value, and the ten years which ended with 1863 may be regarded as the most prosperous decade of British agriculture. It is to illustrate this great prosperity that details of crops and prices are given. Modified prosperity lasted for some years longer, as will be noticed presently.

Agricultural improvement made rapid strides during the very prosperous decade just noticed, and mechanical invention was stimulated greatly. In 1856 Smith of Woolston (see art. SMITH) was working his steam cultivator, and he exhibited it a little later; while Fowler's steam plough, worked by a single engine and an anchor, gained the prize offered by the Royal Agricultural Society in 1857. Improving this plough, Mr. Fowler again gained the prize of 1858, and a little later he brought out his double-engine system for ploughing and cultivating, which, with more or less modification, is still in use. The first reaping machine to be used at all extensively was brought out in 1852, just before the prosperous decade, by Crosskill, based on Bell's machine noticed above; and in 1860 he introduced his great reaper driven by three horses walking behind it, which held the field until Samuelson's one-horse machine came out in 1872. It should be mentioned, however, that American reaping machines were exhibited at the Great Exhibition of 1851, and worked on the farm of John Joseph Mechi, at Tiptree, in Essex.

Agricultural science was being popularized in the prosperous period by Lawes and Gilbert, of Rothamsted, Voelcker, Henslow, Lindley, Buckland, Liebig, Boussingault, Ville, and others (see arts. BOUSSINGAULT, LIEBIG, LINDLEY, LAWES, GILBERT, VOELCKER, and VILLE). The agricultural press, including the Journal of the Royal Agricultural Society of England and the Transactions of the Highland Society, greatly helped the dissemination of science as applied to agriculture, and Alderman Mechi (see art. MECHI) was an enthusiastic advocate of all that was new in agriculture. Mr J. C. Morton, editor of the Agricultural Gazette, must also be mentioned as one who did much to popularize all new sources of agricultural information (see art. MORTON).

As most of the harvests of the 'sixties were good ones, and the prices of corn were high when they were deficient, while meat and dairy produce sold well, agriculture continued to prosper, though great losses, and ruin in some cases, were caused by rinderpest in 1865–7. In some years, moreover, exceptionally heavy losses were occasioned by foot-and-mouth disease and pleuro-pneumonia. The splendid harvest of 1868, when the prices of the three principal cereals were high—wheat averaging 63*s.* 9*d.*, barley 43*s.*, and oats 28*s.* 1*d.*—helped materially to maintain the good fortune of farmers.

In the 'seventies it was a case of 'up horn, down corn'; for, although corn prices were moderate or high up to and including 1874, helped by the Franco-German war in 1870–1, only two of the harvests were up to the mark, and that of 1879 was one of the most disastrous ever known; whereas the prices of meat and dairy produce were higher than those of any decade before or since. Wool had fallen in price materially after 1867, and it remained at what was then regarded as a very low level throughout the 'seventies. Agricultural depression began to be talked about as early as 1876, and in 1879 it became very severe. From preceding statements it will have been noticed that the natural result of the repeal of the Corn Laws in reducing the prices of corn had been counteracted from time to time by such causes as the gold discoveries and wars in Europe, India, and the United States. But after 1873, when the demonetization of silver took place, the prices of commodities as a whole in this country fell almost constantly for ten years, until the lowest level since averages were taken was reached. The Russo-Turkish war in 1877 gave a temporary upward movement to the price of wheat, but that year was the only one after 1874 in which the average was as high as 47*s.* Barley and oats kept up better in value all through the 'seventies, but not much longer, the average for the former not having been as high as 30*s.* since 1885, while that of the latter has been under 21*s.* since 1883. Imports of wheat, including flour, had never exceeded 10,000,000 qrs. until 1872–3, and before the end of the 'seventies they exceeded 16,000,000 qrs. Imports of other kinds of corn also increased greatly. As to animal food, although the imports increased enormously during the decade, prices, excepting that of cheese, remained high, and those of meat increased.

The Royal Commission appointed in 1879 to enquire into the depressed condition of agriculture and its causes published its final report in 1882, in which 'distress of unprecedented severity' was described. It was attributed to a succession of unfavourable seasons, increased foreign competition, the increase of local taxation, cattle disease, and other causes.

The depression deepened for some years, until rents had been adjusted and farmers had reduced their labour expenses, partly by converting much arable land to pasture. Rural depopulation, which had been considerable between 1871 and 1881, made further progress in the next decade. But, apart from the fact that many had to seek work elsewhere than in their native villages, the farm labourers did not suffer from the depression, as wages were higher than they had been in the prosperous times for agriculture, while nearly all the necessaries and most of the luxuries of life were cheaper.

The harvests of the 'eighties, after the first three, were much better than those of the 'seventies; but depression, as stated, became more severe. Multitudes of farms were thrown upon the hands of their owners, and a great number of farmers were ruined. In 1893 another Royal Commission was appointed to investigate the distressful condition of agriculture, and in the report land in Great Britain was stated to have fallen in capital value between 1875 and 1894 by £834,838,000 in round figures, or 50 per cent, allowance being made for a fall from thirty to eighteen years' purchase of the annual value. The evidence showed falls in prices in the preceding twenty years of 40 per cent for the three principal cereals together, 24 to 40 for beef, according to quality, 20 to 30 for mutton, 50 for wool, nearly 30 for dairy produce, and 20 to 30 for potatoes. These falls were generally attributed to foreign competition. By way of finishing this branch of the subject it may now be added that various adjustments, stringent economy in the employment of labour with the help of improved implements and machines, a prolonged series of generally good harvests, and a reduced scale of living since the end of the 'eighties, have enabled farmers as a rule to pay their way, but that there has not been any revival of agricultural prosperity up to the present time.

Before going back to the 'seventies in reference to other subjects than the one just noticed, it is convenient to diverge in order to refer briefly to some efforts, successful or otherwise, to benefit agriculture by legislation, apart from the Corn Laws and Tithe Commutation, already mentioned. As early as 1835 Mr. Sharman Crauford endeavoured to legalize tenant-right customs that had grown up in Ireland, and in 1841 Lord Portman made a similar attempt for England in the House of Lords, followed in 1847 by his co-operator, Mr. Philip Pusey, in the House of Commons. Mr. Pusey's Bill resulted in the appointment, in 1848, of a Committee, of which he was chairman, to take evidence upon the agricultural customs of England and Wales. Mr. William Shaw, editor of the Mark Lane Express, was a strong supporter of these early efforts to obtain security for tenants' improvements, and his successor, Mr. Henry Corbet, followed in his footsteps. Later on, Mr. Clare Sewell Read (see art. Read) and Mr. James Howard were among the foremost champions of tenant right, and they introduced a bill on the subject with which, however, they did not long persevere. The name of Mr. George Hope, of Fenton Barns, is also connected with these early efforts, and in later years Mr. Samuelson (afterwards Sir Bernhard Samuelson), Mr. James Barclay, and other members of Parliament were prominent in the same connection. It was not until 1875 that the first Agricultural Holdings Act was passed. The Act was hardly at all effective, except indirectly, and extended measures have since been passed. For Ireland Mr. Gladstone's Land Act and numerous other measures, culminating in the Land Purchase Act, have been enacted. During the second half of the nineteenth century and since, measures dealing with the tithe rent-charge, game, local government, rates, the sale of adulterated butter and other produce, cattle disease, the sale of adulterated manures and feeding-stuffs, and other subjects, have been made law. The legislation for the suppression of cattle disease and for the prevention of its introduction from foreign or colonial sources has been of incalculable advantage to owners of live stock.

It is now necessary to go back to the 'seventies in order to notice a few important events. In 1870 the Science and Art Department began to offer grants to elementary schools in respect of instruction in the principles of agriculture, and shortly afterwards established classes for training teachers on the subject. Except for a grant from Parliament to the Chair of Agriculture in the University of Edinburgh in 1868, this was the first apportionment of public money to agricultural education in Great Britain. In further reference to agricultural education, the beginning of the senior examinations of the Royal Agricultural Society in 1869 deserves notice.

In 1871 the Agricultural Labourers' Union was formed by Mr. Joseph Arch, and soon extended over the greater part of England. The movement was not without justification in many counties; but the agitators who led it put themselves in the wrong by gross exaggerations and misstatements, and the Union did not long survive the successful lockout which the farmers of the eastern counties established and maintained against it. In 1874 the Agricultural School at Aspatria was founded by an association of gentlemen. The British Dairy Farmers' Association, which has had a great influence upon the dairy industry, was started in 1876. Field and feeding experiments were started at Woburn by the Royal Agricultural Society in 1877. In 1880 Professor Wrightson opened the Downton College of Agriculture as a private venture. The first of the collegiate centres of agricultural education was the agricultural department of the University College of North Wales, which was founded in 1884. Many similar institutions have been established since that date in England, Wales, and Scotland. The existing Board of Agriculture in 1889 superseded the Agricultural Department of the Privy Council, which dated from 1883, with Mr. Jacob (afterwards Sir Jacob) Wilson (see art. Wilson) as its 'Agricultural Adviser'. The Department of Agriculture for Ireland was established and liberally endowed by Parliament in 1899. Agricultural education in Great Britain has been greatly encouraged by the Board of Agriculture, and the veterinary division of the Board has done effective work against some of the diseases of animals. The comparatively young department in Ireland has shown great activity in comprehensive efforts to improve the agriculture of that division of the kingdom.

Agriculture in Ireland has been greatly helped, since the period of depression set in, by co-operation, particularly in the establishment of creameries. The Agricultural Organization Society in that country has done an incalculable amount of good by inducing farmers to co-operate in this and other branches of production, and in the establishment of agricultural credit associations. Recently the useful work has been carried on in Great Britain by a kindred society, and many co-operative societies and agricultural loan banks have been founded.

In the last decade of the 19th century and the first seven years of the present one, the great majority of the corn harvests have been abundant; but prices have been extremely low, the average for wheat having been 30*s.* per qr. or more in only five years, while that of barley has only once reached 28*s.*, and that of oats has not touched 21*s.* Therefore corn has continued to go out of cultivation, and permanent pasture to increase. In England, milk-selling and stock-keeping, in Scotland the same and cheese-making, and in Ireland breeding and butter-making, have become more and more the sheet anchors of farmers.

Since the establishment of agricultural colleges and departments of such institutions, systematic field experiments have become very numerous, and much information as to the most economic production of good crops has been gained thereby. For some years past there has been a strong movement in favour of increasing the number of small holdings and allotments, for promoting which measures for England and Scotland respectively were introduced in the session of 1907.

Among the helps to agriculture at the hands of science in comparatively recent years the discovery by Hellriegel and Wilfarth of nitrifying bacteria in connection with excrescences on the roots of the legumes, and the still more important and more recent conversion of atmospheric nitrogen into manure on a commercial scale, demand recognition. Similarly, the prolonged labour of Miss E. A. Ormerod in relation to injurious insects deserves notice. Spraying for the destruction or checking of insect and fungus pests, including the potato disease, and for the killing of charlock in corn crops, is one of the practical results of scientific investigation. As to the numerous improvements of mechanical agricultural appliances, the self-binding reaping machine stands out as one of the most important. It was brought out in the United States in 1870, and came into use in this country a few years later.

With respect to the future of British agriculture, it is not unreasonable to expect that, as the population of comparatively new countries encroaches upon their food-producing resources, the prolonged depression will steadily pass away, and the cultivators of the soil will obtain the fair share in the division of the wealth of the community which circumstances have denied to them for many years past.

Although in the Middle Ages agriculture in Italy, Flanders, and probably Germany was more advanced than it was in Great Britain, this ceased to be the case at least a century ago, and it is not too much to say that this has been the leading agricultural country of the world since the end of the 18th century. But Holland, Belgium, Germany, Hungary, and France have long been close to the foremost rank, while Denmark in recent times has come to the front in butter-making and the production of bacon. In nearly all the countries of Europe, corn-growing has been preserved more or less by means of high duties on imports, and in some, such as Russia, Roumania, and other eastern countries, it has greatly increased. At the beginning of the 19th century, agriculture in the United States had made comparatively little advance in the hundred years which had elapsed since colonies began to be scattered along the coast of the Atlantic. Although cotton was one of the earliest crops to be cultivated on the great plantations, less than 156,000 bales were produced in 1800, whereas the quantity in 1905 was over 13,500,000 bales, the succeeding crop being a smaller one. The increase in rice has been on a corresponding scale. Statistics of the production of wheat and maize do not go back so far; but in 1821 the value of all unmanufactured foodstuffs exported, including animals, was only 2,474,823 dollars, as compared with 177,216,467 dollars for 1906. The production of maize in 1840 was estimated at less than 378,000,000 bus., and in 1906 at over 2,927,000,000 bus.; and in the same period the production of wheat rose from less than 84,824,000 to over 735,000,000 bus., and the number of cattle from 14,971,600 to 66,861,500. For more than half a century, however, the country has led the world in labour-saving implements and machinery.

It is not long since Canada first became a considerable exporter of wheat, cheese, and some other agricultural products; but since Manitoba and the North-west became settled the progress of production has been very rapid, particularly that of wheat. In Australia and New Zealand the production of meat, wood, and butter for exportation has had the most remarkable development. Our great Indian dependency also in recent times has greatly developed its resources in reference to cereals, tea, and textile materials.

In the Argentine Republic agriculture is of comparatively recent introduction, so far as tillage on a large scale is concerned, and it has made very rapid progress in recent years.

From almost all quarters of the globe foodstuffs flow in increasing volume to this country, and our great population becomes less and less dependent upon agriculture in the British Isles.

[W. E. B.]

Agrilus viridis, &c. (The Beech and Birch Agrilus).—This beetle attacks mainly sapling beech, also birch, aspen, and oak. It is ¼ in. long and belongs to the family Buprestidæ, long, slender beetles of usually metallic lustre; it varies from olive-green, blue-green, to blue-black ventrally. Appears June and July in bright sunshine. Ova laid on bark of saplings near ground. *Larvæ* appear in August, as white, legless grubs; first segment broad, usually flattened. They burrow between bark and sap-wood, forming winding passages even into the wood. They live for two or three seasons, and pupate in April and May in the bark or sapwood in cocoons formed of wood chips. The beetles emerge through holes in the bark, which are oval below, straight above. Two smaller and commoner species, *A. angus-*

tulus and *A. laticornis*, are found amongst hazels, oak, and birch.

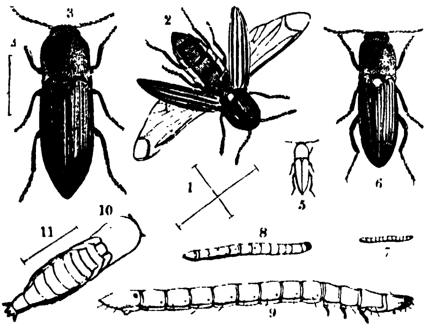
Treatment.—Destroy infested saplings in April. Smear neighbouring saplings with lime and sulphur to stop egg-laying. [F. V. T.]

Agrimony (*Agrimonia Eupatorium*).—This is a perennial herbaceous species with yellow flowers, belonging to the Rose family. Its leaves are compound pinnate. The inflorescence is a loose spike. The fruit is remarkable, being composed of a hard, top-shaped calyx tube, with a circle of hooks on its outside, and containing one or two achenes.

The plant is a common weed on the borders of corn-fields and on roadsides. [A. N. M‘A.]

Agriotes (Click-bettles).

Agriotes lineatus (Striped Click-beetle).—See 1 in fig., showing the natural dimensions of the insect, which in 2 is represented flying. The head and thorax are brown, clothed with cinereous down; the wingcases are of a fulvus colour, with nine punctured lines, forming four brown stripes on each; the antennæ and legs are brighter brown. It is abundant in cornfields, grass lands, hedges, under stones, &c., from May to July.



1, 2, Striped Click-beetle (*Agriotes lineatus*); 3, 4, *A. obscurus*; 5, 6, *A. sputator*; 7, 8, Wireworms, nat. size; 9, magnified; 10, 11, pupa.

A. obscurus.—The obscure click-beetle is of the same size and form as the last, but it is of a uniform earthy-brown colour (see 3 in fig.)—the line at 4 showing the natural length. This beetle is abundant in fields, gardens, pastures, and woods, from May to July.

A. sputator.—The pasture or spitting click-beetle is much smaller than *A. obscurus*; the head and thorax are black, thickly and distinctly dotted; the latter often has the anterior margin and hinder angles, which form short stout points, rusty; the wingcases are light-brown, with nine dotted lines on each; the entire surface is covered with ochreous down; the antennæ and legs are reddish-brown (5 in fig.; and magnified at 6). It is universally abundant, from May to the beginning of July, in cornfields, hedges, and pastures.

These four elaters, or click-beetles, are the parents of the true ‘wireworms’, whose history will be more fully given under that head. Their economy is now well understood; the eggs are laid close to the plant destined to support the young wireworms when they hatch; these larvæ live upon various roots, entering the stems occasionally, and forming burrows in them. They are exceedingly minute when first hatched; and as the different click-beetles vary in size, their wireworms vary also. The small one (7 in fig.) is the offspring of *A. sputator* (5); and 8 of *A. lineatus* (2). The magnified appearance is given at 9. When full grown, the wireworms form a cell deep in the earth, and change to pupæ (10); the line at 11 exhibiting the natural length. At this period of its existence it is in a torpid state, and lies buried as it were in a tomb, until the appointed time, when the spring sun warms the earth, and all the limbs being perfected, the beetle bursts its shroud, forces its tomb of earth, and makes its way to the surface, to dry and expand its wings and limbs, when it is again prepared to generate the species. The click-beetles have the power of springing up when laid on their backs. The wireworms live for three years in the soil, and may even continue for five years. The beetles seek shelter amongst thick vegetation to deposit their eggs. They are frequently found towards evening resting on the summit of grasses. The wireworms flourish best in pasture land, and wherever else they are not disturbed. See WIREWORM. [J. C.]

Agromyza iridos (The Iris Leaf Miner).—A small fly belonging to the family Agromyzidæ; it is a great pest to horticulturists, attacking and destroying the leafage of *Iris gigantea*, and it also occurs in *Iris Pseudacorus*. The small grey flies hatch out in March, April, and May, and again later. They deposit their ova on the leaves, and the larvæ eat them out and speedily cause their death. Great numbers occur in each leaf, and there in the dead leaf they change to brown puparia. Not only the leaves, but the sheaths are often found full of this insect.

Treatment consists in at once cutting off and burning all dead and decaying leaves. [F. V. T.]

Agronomy.—This is a term which has been appropriated to that specialized branch of the general science of agriculture which deals with field crops and their cultivation. In Britain the office of Professor of Agriculture includes among its duties the giving of instruction in live stock, crops, manures, soils, management, &c., and the investigation of problems connected therewith. In North America, and to a less extent in some European countries, these are subdivided into separate departments of knowledge and research, with experts in charge, whose duties are restricted to their own special departments. The agronomist conducts investigations into the growth of crops, methods of cultivation, rotations, &c., and disseminates the knowledge so derived by means of farmers' bulletins, as well as by systematic courses of instruction in the agricultural colleges.

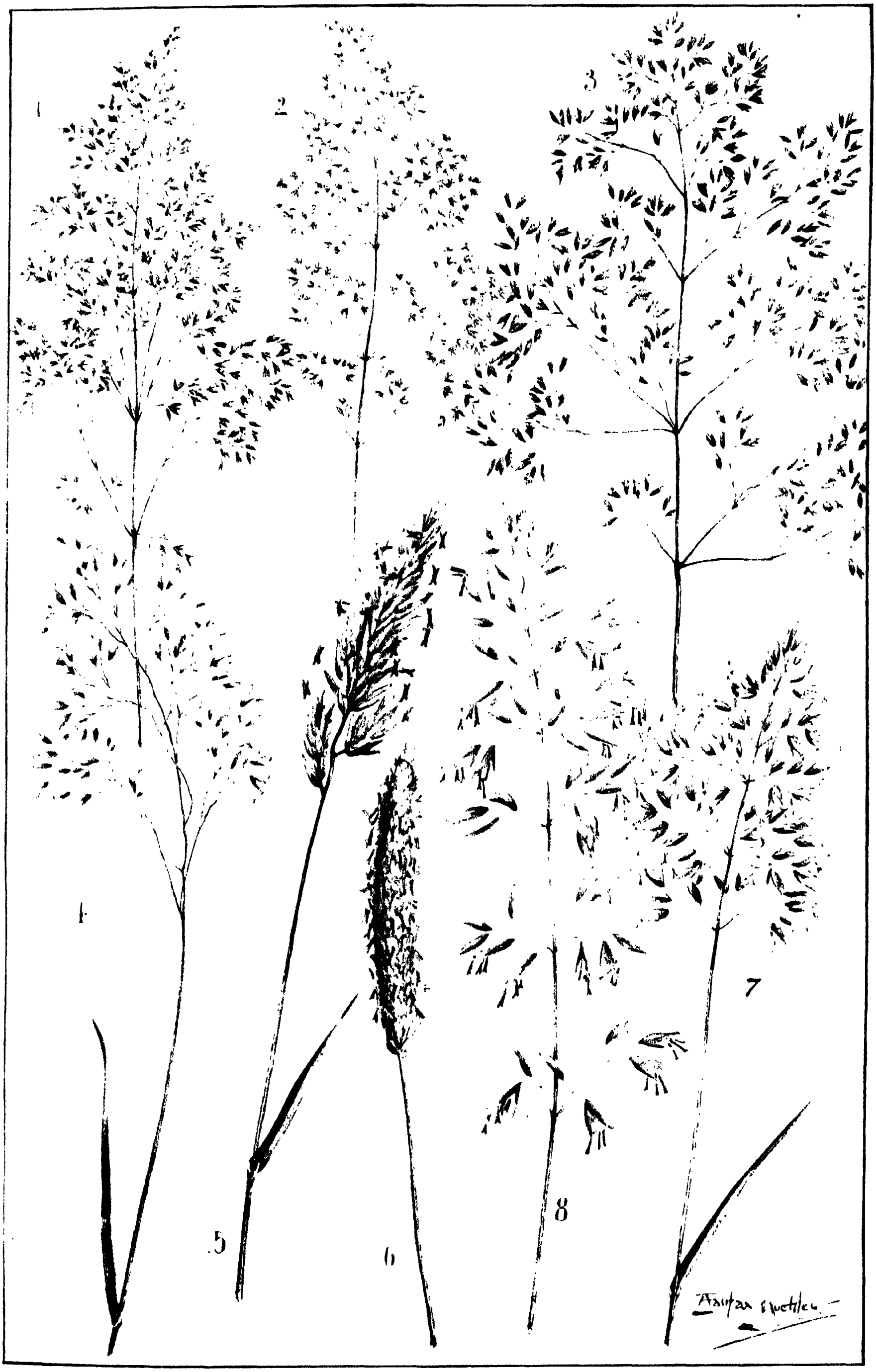
Agrostemma. See CORN COCKLE.

Agrostis.—This genus of grasses belongs to that division of the order in which the spikelets are one-flowered, and the inflorescence a loose panicle. Its spikelets are compressed from

GRASSES—I

1. Agrostis vulgaris. Common Bent Grass.
2. Agrostis alba. Marsh Bent or Fiorin.
3. Aira cæspitosa. Tufted Hair Grass.
4. Aira flexuosa. Wavy Hair Grass.
5. Anthoxanthum odoratum. Sweet Vernal Grass.
6. Alopecurus pratensis. Meadow Fox-tail.
7. Avena flavescens. Golden Oat Grass.
8. Arrhenatherum avenaceum, var. non-bulbosum. Tall Oat Grass.

GRASSES—I

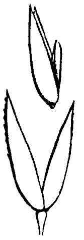


GRASSES—I

the side, its glumes, *a*, narrow and awnless, and its pales, *b*, very unequal. The species are commonly called bents; they are little better than weeds, and are so considered, except in soils where better grasses cannot be obtained.

Of the many species known to botanists only a few require notice.

Agrostis vulgaris (Common Bent, Purple Bent, Black Twitch).—This is a fine-leaved species, with trailing leafy stems rooting at the joints, and small thin panicles of purplish flowers. The glumes (*a*) are of nearly equal length, there is no awn to the pale, and the ligule of the leaf is short and blunt. This plant grows in dry, gravelly, sandy places, which it overruns with its wiry stems, so as to become a troublesome weed, only to be extirpated by pulling up in the early part of the year before its seeds are ripened. Its special uses are for sowing warrens and for laying down lawns. Common bent will accommodate itself to a great diversity of dry soils, and enters into the composition of all natural pastures, from tidemark to the highest zones of gramineous vegetation. It varies much in habit. Its most predominant variety in stiff wheat lands often attains to the height of 2 ft., has strong prostrate stems, broad foliage, and loose widely-spreading panicles, varying from light-green to dark-purple.



Spikelet of *Agrostis vulgaris*

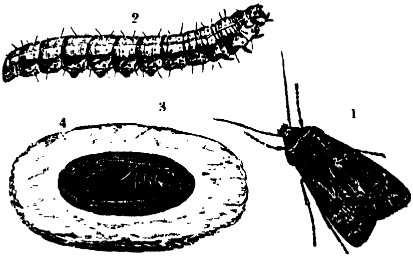
Its opposite extreme, the *A. vulgaris pumila* of botanists, is to be met with on bare gravelly mountain pastures, and on the sides of hill roads, forming small tufted plants, often under 2 in. in height.

By far the most common form of Bent Grass is an intermediate variety, which proves a troublesome weed in light corn lands, and a too predominant grass in secondary and inferior pastures laid down with Rye Grasses. It is late to appear in spring, and decays early in autumn, while its creeping and thickly spreading stems displace valuable grasses. Hence extirpation rather than cultivation is generally the object of the stock farmer. Instances, however, occur, in which its power of withstanding extreme drought, and its adaptation for covering with verdure otherwise barren ground, such as the outskirts of blowing sands, rocky debris, dry banks of railways, lawns, &c., recommend it as a subject for culture. Under such circumstances it may be sown in mixture with other grasses, at the rate of from 1 to 6 lb. of seed per acre, which may be done in moist weather upon the bare surface. The smallness of the seeds renders their vegetation uncertain if they are covered by earth to a greater depth than ¼ or ½ in.

A. stolonifera, or Fiorin, is, in its natural state, chiefly confined to the better descriptions of moist soils over which water does not stagnate, such as alluvial banks of rivers, muddy shores, partly decomposed peat, sides of ditches and rivulets, irrigated meadows, cultivated clay lands, &c. About the commencement of the last century, Dr. Richardson, of Portrush, Ireland, created considerable sensation in the agricultural world by his highly flattering accounts of the growth of this grass on improved bog land. In mixture with other grasses it merits cultivation in consequence of the rapid growth of its stoloniferous shoots, and their retention of verdure in many cases throughout the winter, and even until replaced by the earlier grasses of spring. In propagating the Fiorin, its first growers resorted to the expedient of chopping its long trailing stoloniferous shoots into pieces of from 3 to 6 in. in length, which were then scattered in moist autumn weather on the surface of well-prepared ground, and then lightly harrowed or rolled in: but now its seeds can be had from the principal seed merchants in any quantity, and of these it will seldom be expedient to sow in mixtures a greater quantity than 2 lb. per acre, unless for soils too wet for most other grasses; and most frequently 1 lb. of seed will suffice, especially if the soil be previously well pulverized. The quantity of commercial seed to cover 1 ac. is about 15 lb.

[J. L.]
[A. N. M'A.]

Agrotis.—*A. exclamationis* (Heart-and-Dart Moth) is one of the Noctuæ, or night-flying moths. When at rest the wings lie flat on the back (1 in fig.), as in most night-flying Noctuid moths. It is of a clay colour; the antennæ are longish, slender, and slightly toothed in the male. It has a strong spiral proboscis; there is a blackish stripe in front of the thorax; the upper wings have three waved indented lines across them, one close to the base, and on the disc is a long blackish mark, an ear-shaped spot, and an oval one, or a little dot in a ring; under-wings, pale, the superior margin and nervures brownish: in the female the under-wings are brownish. When expanded the wings are 1¾ in.

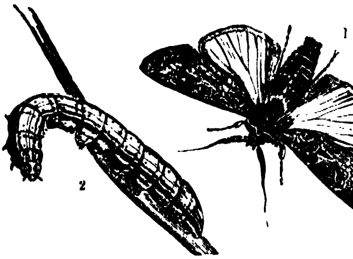


Heart-and-Dart Moth (*Agrotis exclamationis*)

1, Moth; 2, caterpillar; 3, earthen case; 4, pupa.

The caterpillar is of a dull lilac-brown colour, with a broad ochreous stripe down the back, and a double line along the middle. The head is brightish brown; the jaws, a spot on the eyes, two oblique lines and a dot, black; the first thoracic segment is horny and brown, mottled; the other segments have four minute warts on each, and several on the sides, bearing short hairs; the eighteen spiracles, or breathing pores, are black; and it has sixteen feet (2 in fig.). When full grown in autumn it buries itself, forms an earthen case (3), and changes in it to a brown or pitch-coloured pupa (4), from which the moth emerges about the end of June.

A. segetum (the Common Dart Moth) is very similar in size and form to the foregoing: the antennæ of the male are more distinctly toothed, it wants the black spot in front of the thorax; the upper wings are generally more brown and freckled, the long dart-shaped mark is lighter, and the other spots larger: there is a line of black dots at the base of the fringe also; the under wings are white, with an opalescent tint (1 in fig.). The female is much darker, with the markings less distinct, and the under wings are dirty-white. It is abundant in June and July, when the females lay their eggs on the earth, from which the caterpillars hatch, and become full grown in about nine months, when they are transformed to pupæ: they greatly resemble the former species, but are smoother, shining, less depressed, and the hairs are shorter: they are of a dull-greenish ochre, the space down the back is of a rosy tint; the eyes are ochreous and dotted, with a black X on the face: the first thoracic segment is horny, shining, and brown, with three pale lines; the dots on the segments are blackish, and on the sides of each are three, forming triangles.



Common Dart Moth (*Agrotis segetum*)

1, Moth; 2, caterpillar.

The economy of these caterpillars, with several others, will be given under SURFACE GRUBS, the name by which they are commonly designated, from their living upon or just below the surface of the earth. They are most destructive creatures when they attack the growing crops of turnips, mangel-wurzel, potatoes, corn, and garden produce, such as lettuces, beet, spinach, auriculas, and various flowers, which fall a sacrifice to them. [J. C.] [F. V. T.]

Ailanthus.—The Tree of Heaven, *A. glandulosa*, is a native of China. It is a tall, rapid-growing tree, with leaves like those of the common ash but much longer, and clusters of greenish flowers with a disagreeable odour. It grows well in the British Isles, and is often planted as a shade tree in parks and public places. The wood is yellowish-white and has a value in this country. In China the leaves form the food of silkworms, and some years ago the tree was planted in France for the same purpose, but it did not prove a success. It thrives well in sheltered localities near the sea, but it will not stand strong winds. It has been in cultivation in this country about 150 years. [W. W.]

Air. See ATMOSPHERE.

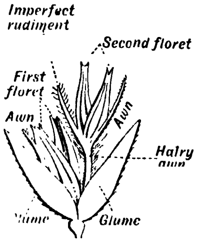
Air. See NUISANCE, SERVITUDE.

Aira.—In this genus of grasses each spikelet has two awned florets, and the ear is a loose panicle. Only one species is recognized among agricultural plants, and it, like the others of the genus, is to be regarded as a weed.

Aira (or *Deschampsia*) *cæspitosa* (Tufted Hair Grass; Hassock Grass; Tussock Grass.—This is a coarse, fibrous-rooted perennial, forming great tufts or tussocks, which, when in flower, are as much as a yard high. The leaf-blades are harsh, very rough on the surface and along the edges, and roll up when dry. The ligule is long, sharp-pointed, and often split. The ear is a large, handsome panicle, divided into a great number of horizontal, hair-like, elastic, rough branches. The spikelets are somewhat purple, and gleam in the sun as if polished. Each spikelet is composed of two glumes and two florets borne on a hairy axis. The end of the spikelet axis is a short hairy bristle, which botanists call an 'imperfect rudiment'. The awns of the florets are basal and straight, not longer than the pale which bears them.

This plant is very common in moist rich soils, especially in shady plantations, in undrained meadows, and in undrained hill pastures. Its coarse, harsh, wiry herbage renders it disliked by cattle, which feed round it, and thus its tussocks are rendered the more conspicuous.

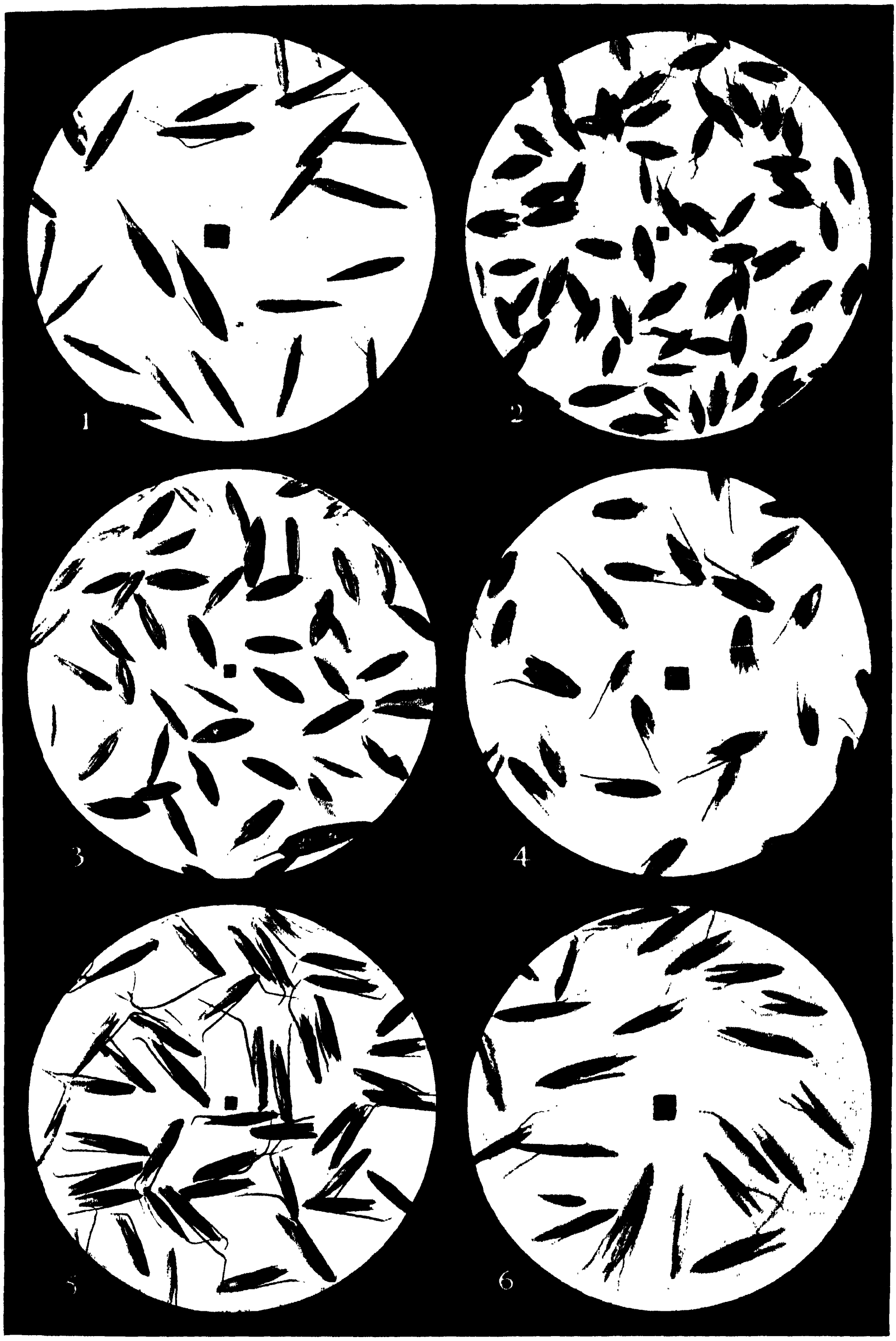
Tufted Hair Grass is suitable as covert for game, where quality is of no consequence. For covert in moist shaded woods the seed may be sown in quantities of from 2 to 6 lb. per acre. In cultivated land Tufted Hair Grass is a nuisance, and not easy to extirpate. Although not 'creeping rooted', yet it has short underground stems which mingle with the roots, and these being broken off when the tufts are forced out of the land, remain behind and propagate the plant. In the absence of paring and burning, and thorough drainage of the land, there seems no better way of eradicating than bodily removal. Mowing, certainly, may do some good, but unless the mowing is persevered in from early spring till winter there is no hope of destroying the vitality of a plant so tenacious of life. The least expensive mode of attack is to pull up the tussocks, and to watch the places where they were, removing by hand the young plants which come up afterwards. A boy may be easily taught to distinguish so coarse a grass from those which it infests.



Spikelet of Tufted Hair Grass (*Aira cæspitosa*)

But any means employed for extirpation will prove futile, unless combined with perfect drainage. Drainage alone will ultimately lead to its displacement. Moisture is so essential to con-

SEEDS OF GRASSES—I



1, Aira flexuosa; 2, Alopecurus pratensis; 3, Alopecurus agrestis; 4, Anthoxanthum odoratum; 5, Arrhenatherum; 6, Av
flavescens (The comparative degree of enlargement may be gauged by the size of the small central square = 1 millimet

tinued healthy growth of Tufted Hair Grass that a very correct estimate of the state of drainage in a country may be formed from observing the prevalence and state of vigour of this plant, whether on roadsides or in pastures, on hedge banks or in plantations. Its associates in plantations are willow bushes, birch and alder, decaying hawthorns, stunted hardwood, scraggy moss-covered Coniferæ, and other indicators of excessive saturation. The presence of Tufted Hair Grass is sometimes tolerated on upland moor farms, from its adding largely to the bulk of coarse bog hay, so necessary for the winter sustenance of the hardy stock of such districts. In pasture lands, however, it should invariably be eradicated.

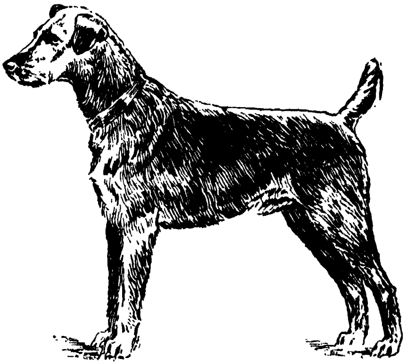
Several other kinds of Hair Grass are found wild in this country. *Aira præcox* and *caryophyllea* (Silvery Hair Grass and Early Hair Grass) are dwarf, silvery, early annual species, which indicate light land of the worst quality.

Aira flexuosa (Wavy Hair Grass) is a bristle-leaved species found on heaths, whose 'seeds' are sometimes used as substitutes for Golden Oat Grass.

[J. L.]
[A. N. M'A.]

Air Drainage. — A departure from the ordinary method of drainage, devised by Hutchison with the object of increasing the fertility of the soil. The methods of procedure and the advantages that were expected to ensue from air drainage are laid down in his Practical Instructions on the Drainage of Land on Hydraulic and Pneumatic Principles. A drain is dug all round the upper ends of the system and left open, a current of air being thereby induced in all the drains of the field. Obviously, such a current of air cannot by any process of reasoning be supposed either to increase the fertility of the soil or to be available for the plant roots in it. It simply enters at the top ends of the drains, is carried down by the water in them, and finally gains exit at the outlet. A consideration of what happens in the ordinary way will show that it is unnecessary to adopt such a course in order to secure what is in fact the primary aim of drainage, viz., the flow of air and water from the surface of the soil to the drains. Water finds its way down by the force of gravity, through the interstices of the soil, and in so doing leaves behind it an area of diminished pressure which causes air to flow in, according to the well-known law. In this way the soil is aerated, plant roots get their necessary supply of oxygen, injurious compounds are oxygenated, and the oxygen-depleted air ultimately got rid of at the discharge. It is only this air travelling from the surface to the drain that can be considered to increase fertility and productiveness, and it is not in accordance with hydraulic and pneumatic principles to suppose that air admitted directly into the drain at its upper orifice will seek its way out of the drain into the surrounding soil. On the contrary, it is more likely that the constant presence of an abundant supply of air in the drain will lessen the tendency for it to permeate the soil in the way above indicated. The ordinary system of drainage with closed ends is, in fact, a very efficient air drainage in itself, and no advantage can be expected to accrue from leaving the ends open as in Hutchison's method.

Airedale Terrier. — This is the modern designation of a breed of dogs which formerly had its home among the hills and dales of Yorkshire, particularly in the valley of the Aire, where it used to be known as the 'Broken-haired or Working Terrier', or better, perhaps, as the 'Waterside Terrier'. The latter term was recognized to be the most appropriate to the character and disposition of the dog, whose strength and hardihood and indifference to cold and exposure renders him peculiarly adapted for work in and about the rapid streams of his home county. This name, however, was considered to be too general in its application, being equally descriptive of work also done by other and quite distinct varieties of terriers. The name of 'Airedale' was first suggested by the late Mr. Hugh Dalziel—an eminent authority on dogs—and has attached itself to the breed ever since.



Airedale Terrier

The inclusion of this dog among the group of terriers is apt to be misleading, for he is altogether too big for the work usually associated with the group. He has been likened to a sort of giant relation of the Dandie Dinmont and the Bedlington, with more than a dash of hound blood in his composition. He is, however, larger and stronger built than either of these two, scaling from 40 to 45 lb.—rounder in the rib and wider in the haunches than the Bedlington, longer in the leg and proportionately shorter in the body than the Dandie. His appearance first and last suggests strength, from his powerful jaws and muscular neck and shoulders to his straight, strong legs and good feet. The hind quarters are square, and finished off by a thick, coarse tail, docked to about one-half, while the whole body is stout and compact. The coat is short and wiry, and of a fairly even mixture of hard and soft hair of a prevailing grizzled colour, but with tan spots here and there on face, legs, and saddle. The puppy, however, is much darker and smoother, resembling more the black-and-tan terrier. The darker the coat at this stage the greater the prospect of a good adult coat, and a promising puppy should also be endowed with straight, well-boned fore legs, a nice small ear, and dark eyes.

Bold and unflinching in work, yet good-tempered and obedient, the typical Airedale commends himself as a country companion—equally good for rat or otter, duck or water hen.

Air Space in Buildings.—The principle underlying the subject of air space in buildings consists in the free admission and circulation as fresh air of the oxygen essential to the vital processes of the animals occupying them, and in the discharge of the carbonic acid gas and other injurious emanations of the animals (see below). It has also to be considered how this interchange can be most effectively brought about, while at the same time an equable temperature is maintained.

In 100 volumes of pure air there will usually be present about 21 volumes of oxygen, 78·5 of nitrogen, and ·03 of carbonic acid gas, the remainder consisting of other gases and water vapour. Ordinary air will contain 20·96 per cent of oxygen by volume, while an impure air may not contain more than 20·6 per cent. So far as the animal economy is concerned, the nitrogen acts simply as a diluent of the oxygen. Carbonic acid gas acts as a poison on the animal body. A difference of ·2 per 1000 volumes in buildings renders the air unpleasant, while an increase of 1 part per 1000 is distinctly unhealthy.

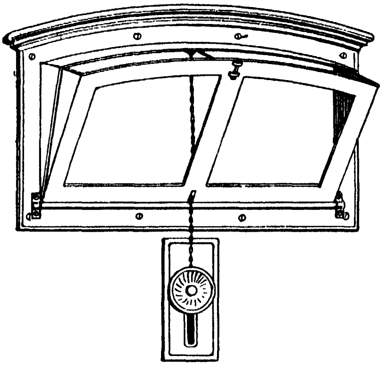
It must not be supposed that if a stable or shed is big, and only one horse or cow in it, it is unnecessary to ventilate it. The air of that dwelling may become as impure as that of a small habitation if the place be not kept well ventilated. There will, of course, not be so much draught in it if windows and doors are open. In that respect it is advantageous to have plenty of moving room, but the mere size of a dwelling is no guarantee of the purity of the air within it.

An abundant supply of fresh air without a draught is the thing to be aimed at in all buildings occupied by stock.

The air entering a cowhouse or stable should not pass over a manure heap, cesspool, or rubbish heap, but should come in preferably over green fields and wide open country. Otherwise the air may contain such gaseous impurities as ammonia, sewer gas, marsh gas, and sulphuretted hydrogen, all of which are hurtful, their effects on animals being bad appearance, nervous troubles, colds, coughs, pneumonia, and ophthalmia, while if an epizootic disease occurs, it is much more fatal in such an impure atmosphere. It is not advisable to have windows and stable doors opening to the east, unless rising ground or trees and bushes shelter the place from that aspect. Everybody knows the old couplet, 'When the wind is in the east, it's neither good for man nor beast'; and when a draught from the east comes through the door on to a sweating animal, or a man in his shirt sleeves, it is doubly bad for them.

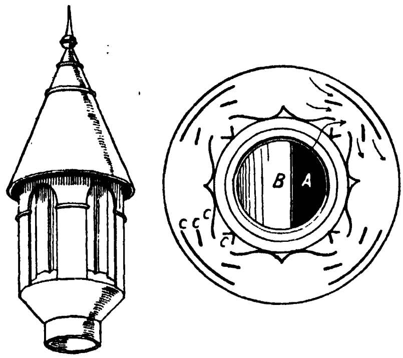
From what has been said above, it will be seen that the air of a stable or cowshed is never so pure as the outside air. The purity of it may be gauged by the amount of carbonic acid gas in it. The sense of smell also will tell an attendant or owner whether the air of his stable is fairly pure. The whole air in an animal's dwelling should be changed several times during an hour. This should be accomplished without a draught. The idea to be aimed at is to give the animal air similar to that outside its dwelling without subjecting it to wet ground, inclement weather, or excessive sun heat.

When it is considered that animals live, eat, sleep, drink, defecate and urinate all in one place and under one roof, it is not difficult to conceive how the air may be rendered foul by the carbonic acid gas and marsh gas expired by the animals and by the ammonia arising from the urine and dung. This fact also accounts for the presence of organic impurities in the form of dust, scales, dried pus, hair, vegetable fibre, bacteria of various kinds, epithelium from the respiratory passages, skin, &c. These may become attached to woodwork, walls, and ceilings, hence periodical limewashing and cleansing of mangers, walls, and stall posts should be regularly resorted to. All outlets for drainage from cowhouses should be regularly flushed with some disinfectant, or, better, trapped, and the sewer into which the drain passes should be ventilated.


Sheringham Inlet Valve

Inlets for fresh air should be made in the walls, and outlets in the roof. Perforated bricks, carried round beneath the eaves of a stable or cowshed, form good inlets. Louvre-boards, well set, are good outlets. The Sheringham ventilating window is now largely used in many stables, and is strongly recommended by Colonel F. Smith, A.V.D., in his book on Veterinary Hygiene. The best outlet in all stables is a tube with a revolving ventilator, causing a constant flow of air out of the stable or shed.

While the importance of a pure milk supply has brought the question of air space in cowhouses prominently before sanitary authorities and has resulted in the formulating of regulations regarding air space, particularly in Scotland (see succeeding article), no systematic enquiry has been directed to the air space requirements in stables. From the farmer's point of view, however, this is quite as important as in the case of the cowbyre. In his daily work great strain is put on the lungs of a horse, and when doing hard work the amount of carbonic acid excreted is double that given out when at rest. Hence, when he returns from the open air to the stable and is giving off carbonic acid gas in large quantities from his lungs, it is of prime importance to give him good ventilation and a free supply of oxygen; and he requires for this purpose to have 15,000 cu. ft. of pure air per hour passing through the stables. The following statistics furnished by Mr. Dollar, M.R.C.V.S., New Bond Street, London, show the variation in cubical content that obtains in a number of London stables:—



Boyle's Air-pump Ventilator

A, Vertical shaft. B, Plate set at an angle to prevent down draught. C, External deflecting plates.

Royal Mews, per horse	2500 cu. ft.
Marlborough House stables, per horse	1700 ,,
S.E. Railway Co., per horse	1540 ,,
Messrs. Reid & Co., per horse	1250 ,,
London, Chatham, & Dover Railway, per horse	1200 ,,
Messrs. East, Curzon Street, per horse	1100 ,,
G.W. Railway, per horse	1116 ,,
London General Omnibus, per horse	820 ,,
Stables, private houses, per horse	720 ,,
Cab-horses' stables, per horse	550 ,,

[G. M.]

Air Space in Cowhouses and Byres.—After the passing of the Dairies and Cowsheds orders of 1885 and 1887, most of the counties of Scotland made regulations for the housing of cows, but those of England did not move to the same extent. The requirements of County Councils in regard to this matter have been in recent years in great part regulated by the suggestions made by the Royal Commission on Tuberculosis for 1897. The paragraph in the report of the Royal Commission on Tuberculosis is as follows:—'(5) A minimum cubic contents as regards such districts (populous places, whether technically urban or rural) of from 600 to 800 ft. for each adult beast varying according to the average weight of the animals.' To this the Commission add the following:—'While we have prescribed a minimum cubic contents and floor space without definite dimensions affecting ventilation and lighting, we are distinctly of opinion, that these are by far the most important, and that requirements as to cubic space and floor space are mainly of value as tending to facilitate adequate movement of air.' Following this a considerable number of the Scottish counties redrafted their regulations, and amended them where thought necessary, and a return compiled in 1902 by the Highland and Agricultural Society of Scotland showed that the cubic space allowed per cow varied enormously in the different counties. In the south-western counties, where the cows are mostly Ayrshires, a common allowance is from 350 to 450 cu. ft. for old buildings, and from 400 to 700 cu. ft. for new ones. In the other counties, where the variety of cattle kept is larger, the space specified is correspondingly greater. For existing buildings 12 counties in Scotland in 1902 specified an average of 480 cu. ft., and 17 counties required an average of 700 cu. ft. for new buildings.

In 1902 this matter was the subject of several interviews between a committee of the Highland and Agricultural Society and the Local Government Board, regarding which the former offered the following suggestions to the Board, which they had reason to believe was on the point of issuing new model regulations:—

'The amount of cubic space should vary with the situation, surrounding conditions, and size of the cow. In low-lying, well sheltered places, a reasonable provision in new buildings would be 600 ft. per head of the largest class of cows, such as Shorthorns, and 450 for the smaller classes of cows, such as Ayrshires. In high-lying and exposed situations from 50 to 100 ft. less for each of these two classes of cows would suffice.

'Where the requirements as to floor space are complied with, all the space between the floor and roof should be included in determining the extent of the cubic space.'

The committee also made the following suggestion:—

'The thorough *ventilation* of houses in which cows are kept should be efficiently provided for, this being of *greater importance* than either floor or cubic space. Both wall and roof openings should be compulsory.'

The Local Government Board did not issue their new model regulations till 1905, and in them they limit the cubic space to 800 ft. where the animals are constantly in the house, and to 600 ft. where they are habitually turned out during the greater portion of each day.

A building which is otherwise suitable, seems not to be difficult to ventilate, so as to keep the air comparatively speaking fresh and pure, and at least free from fœtid odours, provided sufficient openings are constructed in the walls, and others of an equal or greater area are left in the roof. Mere cubic space of itself is of little value in any cowhouse without openings for ventilation, as in a large building with no ventilation the air may become as polluted in a limited time as in a small one with it. A certain area and space is necessary to accommodate the cows and conveniently attend to them, and this, if of moderate amount, admits of more satisfactory interchange of air without causing undue draughts, which are more likely to result if the cubic space is small. Cubic space, ventilation, and heat are so interlocked with each other, when either is considered in connection with cowhouses, that it is almost impossible to consider the one without more or less referring to the other.

Ever since the great demand for winter milk which began in the early sixties of last century, the average cow-keeper in this country has considered it a *sine qua non* of success, that his cows should be kept in a temperature of from 60° F. to 65° F. Mere size of building with or without ventilation has little effect in preserving such a temperature in cold weather, and yet giving even moderate purity of air. The two are incompatible, and without artificial heat cannot be obtained, even if desirable. With cows which are to be slaughtered after their milking period is past, it is a matter of less moment whether or not they remain for a limited period in a vitiated atmosphere, but with those which are to be kept over for several years the matter requires much more serious consideration. As no animal can live for long in a polluted atmosphere without becoming affected in its health, it follows that we must either give up part of the heat if we desire to give fresh air to our stock, or allow them to suffer from the effects of the polluted atmosphere in which they have to pass their days and nights.

In countries with a much more rigorous climate than ours it is customary for cows in full milk to do well in buildings at a temperature of from 45° F. to 50° F. instead of the 60° F. to 65° F. thought necessary here. If this can be done in countries with a winter temperature far below our own, there is no reason why it should not be possible here, as with our open winters there is little difficulty in freely ventilating all cowhouses at any time of the year, and yet rarely having the temperature below 45° F. All that is necessary is to see that the animals at no time of the year are kept warmer than they are intended to be during the remainder of the winter. If this is done, the stock will in early autumn grow a coat of hair which will keep them quite comfortable even at 40° F. or less, while with it they will be oppressed if in a temperature much over 50° F. If such cows are shut up in early autumn in an ill-ventilated building where the temperature soon rises to 65° F. or more at that season of the year, Nature at once finds the heavy covering of hair not only unnecessary, but a burden and an oppression, which the cow soon gets rid of by shedding to such an extent that the animal feels comfortable at the temperature, whatever that is for the time being. Thereafter the animal must be kept at or about the same temperature, otherwise she feels cold in a lower one, which is immediately followed by a corresponding shrinkage in her yield of milk. Cows never kept over 50° F. or 55° F. retain their autumn hair well on to spring, and do not fall off in their milk yield during periods of frost, as cows kept warmer are sure to do. Such treatment may mean a somewhat greater expenditure in food, but it undoubtedly ensures healthier cows and a more wholesome supply of milk. See also arts. on BUILDINGS and VENTILATION. [J. S.]

Air Space in Soils. See SOILS.

Aitken, Andrew P., was born in Edinburgh in 1843, and died in 1904. He was educated at the university of his native city, where he took the degrees of M.A., B.Sc., and subsequently D.Sc. in the department of chemistry. He continued his studies at Heidelberg, and on his return was appointed assistant to Professor Crum Brown and demonstrator in practical chemistry in his *alma mater*. In 1895 he was appointed professor of chemistry in the Royal Dick Veterinary College, a post which he occupied till his death. From 1877 he also held the position of consulting chemist to the Highland and Agricultural Society, and in this capacity he rendered great services to the cause of agricultural research and education in Scotland. For a number of years he delivered an annual course of lectures to students of agriculture, and he conducted a very comprehensive series of experiments on the manuring of the chief farm crops at the Highland Society's experiment stations at Harelaw and Pumpherston, and also on numerous farms throughout the country. His reports on these experiments, which were published regularly in the Transactions of the Society, formed the most valuable feature of many volumes, and supplied the first reliable data that had been furnished to Scotch farmers on the employment of artificial manures. His reports were invariably characterized by width of knowledge, mastery of detail, and a remarkable soundness of judgment, while his grasp of the practical conditions of agriculture has never been surpassed by any agricultural chemist. His work forms the most important contribution made by Scotland in the 19th century to the new science of agricultural chemistry, and the summary of his recommendations, published in the Transactions of 1886, formed by far the most comprehensive and trustworthy guide to the manuring of farm crops that had up to that time been placed before the farmers of Scotland. [R. P. W.]

Aiton, William, a prominent contributor to the agricultural literature of the first two decades of the 19th century, was bred to practical farming in Ayrshire, but his attention being directed to the study of law, he was eventually appointed sheriff-substitute for the middle ward of Lanarkshire. He still, however, maintained his interest in agricultural affairs, and his services were enlisted by the Board of Agriculture in connection with a survey of the agriculture of his native county. His report, following upon this commission, which is entitled 'A General View of the Agriculture of the County of Ayr', constitutes his most valuable work. He is responsible for a similar report on the agriculture of Bute. His other works are an Essay on the Origin, Quantities, and Cultivation of Moss Earth, published in 1811, and a Treatise on Dairy Husbandry, published 1825. [J. B.]

Albino.—The term is applied to those animals and human beings which through some natural defect are without pigment in the skin, hair, iris, and choroid of the eye. It is the condition we are familiar with in white mice, white rats, white elephants, white crows, &c. Beyond the examples named, albinos occur in various other birds and mammals, including man. White negroes occur, but the albino condition is not confined to them amongst men. When the pigment is not entirely absent, but only so in patches, a piebald condition results. Human albinos have a very pale white skin, which is frequently rough, their hair is soft and quite white, the iris pinkish, the pupil contracted and bright red. This redness is due to the absence of pigment in the eye layers exposing the network of blood-vessels. The lack of pigment permits excessive stimulus upon the retina when exposed to strong light, and this albinos generally require to avoid. On the other hand, their condition favours seeing in the dark rather better than normal individuals can do. The condition is undoubtedly hereditary, and is sometimes accompanied by other defects, although albinos are not of necessity lacking in mental vigour or capacity, as has been suggested in the past. The cause of albinism is quite unknown; we can only say that it arises, like many another idiosyncrasy, as a germinal variation. [J. R.]

Albite.—A mineral of the felspar group, having sodium silicate as a constituent. See FELSPARS.

Albumens.—Albumens belong to a class of carbon compounds called proteids. They are of a very complex nature, and contain carbon, nitrogen, hydrogen, oxygen, and sulphur. They occur widely distributed in animal and vegetable tissue, sometimes in the solid and sometimes in the liquid state. When dissolved they form a colloidal solution, from which they can be precipitated, on warming, by the addition of an acid, or of a strong solution of certain salts. They combine with acids and alkalis, forming acid and alkali albumen.

Though the albumens occur in all forms of organized matter, they do not vary much in percentage composition. The average percentage of nitrogen is 16. Recent research has, however, shown that by the action of digestive juices they break down into products of varying qualitative and quantitative composition, according largely to the source of the albumen; and moreover, it was originally thought that one notable difference between animal and vegetable life was that the latter were capable of synthesizing albumen from simpler substances, whilst the former were dependent upon the latter for its supply of organized albumen. The results of investigations in progress by several workers upon this difficult problem show that animals have greater synthetic power of building up particular albumens than that entertained by older views.

A typical albumen is white of egg. They are of great value as a constituent of foods, and are a readily digestible form of proteid. [R. A. B.]

Albuminoid Ratio.—In the economic feeding of farm stock there are many important and perplexing questions to decide, and one of the principal is that relating to the choice of foods. Of these a great variety are available. The well-being of a herd of fattening or dairy cattle very largely depends upon an intelligent selection of the foods for their use. In making a decision as to what he will use, the farmer has to rely to a large extent upon his knowledge of the chemistry of foods. The components of foods fall naturally into three great classes of compounds, namely, albuminoids, fats, and carbohydrates. These, as the reader will find on reference to the article on FEEDING, have different values as foodstuffs. Albuminoids are composed of carbon, hydrogen, nitrogen, oxygen, and sulphur; whilst fats and carbohydrates contain carbon, hydrogen, and oxygen, but no nitrogen. It is manifest from their composition that the two latter groups of substances cannot by themselves be transformed into the highly complex nitrogen compounds of the body. Investigation has shown that these different groups of substances can play special and important parts in animal nutrition. Knowing in a general way their respective functions, the stock breeder and dairyman are confronted with the question—how can they arrange the components of foods in a ration to produce the most satisfactory results? It must be first realized that from the food the animal has to build up new tissues and repair the continual waste that is going on, to provide warmth and energy for mechanical and other work. The general laws of animal nutrition demonstrate that inconsiderate adjustment of the components of rations may result in waste and extravagance, and give rise to unnecessary and sometimes harmful work upon the organs of the body. Moreover, the food requirement of different classes of animals is very variable, and not only does it vary with the different species, but also according to age, and whether the animal is being milked, fattened, or used for hard work. With these conflicting considerations in view, it is clear that in adjusting the foods of a ration to serve different purposes, some basis established on scientific facts is necessary to work upon. As the result of numerous investigations into the various problems connected with the feeding of animals a standard has been adopted, which acts as a guide and a safeguard to the farmer in the feeding of his stock. This standard is called the *albuminoid ratio, or nutritive ratio, and means the ratio of the digestible albuminoid substances to the digestible non-albuminoid substances, or, in other words, the proportion of digestible albuminoids to the digestible carbohydrates and fats.* In computing this ratio, the percentages of digestible constituents, which figure represents the portion that can be utilized by the animal, only are taken. Analyses of the total and digestible constituents of most foods have now been made. The method adopted in working out the ratio is as follows. Convert the percentage of fat into its equivalent of carbohydrates by multiplying the fats by 2·3, add the product to the percentage of carbohydrates, and divide the sum by the percentage of albuminoids. Before giving an example, it should be stated why the fats are taken as being 2·3 times as valuable as the carbohydrates. This proportion represents relatively the total heat or fuel value of the two substances. It is found by taking the same weight of fat and of carbohydrate (starches, sugars, and fibre), burning in air, or oxygen, in a calorimeter, and measuring the amount of heat given out. The above figure, which is the average of a number of determinations, gives in a general way the relative heat value, or the relative measure of the total energy, available to the body from the respective substances. Example:—

Linseed Cake: Analysis

Albuminoids	24·7 per cent.	
Fat	9·6 × 2·3 =	22·08
Carbohydrates ...	29·8	29·8
	24·7)	51·88
Albuminoid Ratio, 1 : 2·1		2·1

Another example: ration composed of—

42 lb. Swedes.
7 lb. Hay.
14 lb. Oat Straw.
4 lb. Crushed Oats.
4¼ lb. Decorticated Cotton Cake.

For working out the albuminoid ratio of the above, the analyses of the several constituents should be obtained from the table given under FOODS. When these are found, proceed as follows:—

Multiply the percentage composition of the fats, carbohydrates, and albuminoids present in the particular food by the number of pounds of the food taken, and then divide by 100, which is best done by moving the decimal point two places to the left, *e.g.*:

	42 lb. Swedes.	Hay, 7 lb.	14 lb. Straw.
Albuminoids, per cent ...	·7 × ·42 = ·294 ...	5·4 × ·07 = ·38 ...	1·4 × ·14 = ·20
Fats, ,, ...	·1 × ·42 = ·042 ...	1·0 × ·07 = ·07 ...	·7 × ·14 = ·098
Carbohydrates, ,, ...	10·6 × ·42 = 4·452 ...	40·7 × ·07 = 2·85 ...	40·1 × ·14 = 5·61

	4 lb. Crushed Oats.	Decorticated Cotton Cake, 4¼ lb.
Albuminoids, per cent ...	8·0 × ·04 = ·32 ...	36·9 × ·0425 = 1·57
Fats, ,, ...	4·3 × ·04 = ·17 ...	10·0 × ·0425 = ·43
Carbohydrates, ,, ...	44·7 × ·04 = 1·79 ...	18·7 × ·0425 = ·79

	Albuminoids.	Fats.	Carbohydrates.
42 lb. Swedes give in pounds	·29 ...	·04 ...	4·45
7 lb. Hay ,, ,, ...	·38 ...	·07 ...	2·85
14 lb. Oat Straw ,, ,, ...	·20 ...	·10 ...	5·61
4 lb. Oats ,, ,, ...	·32 ...	·17 ...	1·79
4¼ lb. Decorticated Cotton Cake give in pounds ...	1·57 ...	·43 ...	·79
	...	·81 × 2·5 =	2·02
	2·76		17·51

2·76) 17·51 (6·3
16 56
950
828

Albuminoid Ratio, 1 : 6·3.

Note.—2·5 (instead of 2·3) is the figure more generally used in practice (as in second example) to convert fats into their equivalent of carbohydrates.

For increasing or decreasing the albuminoid ratio, foods rich in albuminoids and poor in carbohydrates, or conversely, must be added. Besides chemical composition other factors, such as palatableness, healthfulness, supply, &c., of the components of a ration must receive due prominence.

The following albuminoid ratios are those found in general use in the management of stock:—

Young animals on milk	1 : 3·5
Milking cows, half-grown cattle, sheep, and pigs	1 : 5 or 6
Fattening animal and working horse	1 : 8

It is not within the scope of this article to go further into detail upon this subject, for the reason that it will be dealt with more fittingly under the feeding of farm animals. It is, however, essential that the true nature and limitations of the term should be realized. In the first place, it should be pointed out that the so-called standard ratios must not be taken as being infallible and as having reached the goal of scientific research in this direction, for it is well known that widely divergent ratios have in some cases produced results of equal merit, and that different investigators have not, when in pursuit of the same object, arrived at equally concordant conclusions. Yet so far as the results of experience at present indicate, the albuminoid ratios now in use supply data that are of inestimable value to the owner of stock.

Within the last five years considerable light has been thrown upon the difficult problem, the utilization of proteids in the food by the animal. The subject is now at an interesting stage. The results already obtained seem to indicate that the pre-eminent position so far held by proteids in the domain of the chemistry of foods may be somewhat shaken, yet many years may pass before anything tangible or definite enough is achieved to warrant us in revising the views at present held in regard to the respective importance that albuminoids, fats, and carbohydrates play in their capacity as foodstuffs. [R. A. B.]

Albuminoids.—The term albuminoid is used as synonymous with proteid. Under these generic names are grouped a class of chemical substances containing the elements carbon, hydrogen, oxygen, nitrogen, and sulphur. They form the chief part of the solid portion of muscle, nerve, blood, glands, &c., and of the nitrogen compounds stored in seeds and other plant organs. The term albuminoid was, in addition to albumen and allied compounds, formerly applied to gelatin, keratin, &c. More recently there has been a tendency to restrict the term to gelatin and analogous substances, whilst the term proteid is applied to albumen and allied compounds. See Proteids. [R.A.B.]

Albuminuria.—The presence of albumen in the urine of animals, with the exception perhaps of the dog, whether occasional or persistent, is not due to the kidney disease in man with which it is associated. In the equine disease known as azoturia, albumen is found in considerable quantity, as also in the red water of ruminants (hæmoglobinuria). Temporary derangements in the digestive system, and possibly nervous disturbances connected with œstrum, occasionally give rise to the presence of albumen in the urine, and it has been observed to follow on excessive muscular fatigue. By simple chemical tests its presence can be ascertained, and upon its duration and quantity in subsequent samples examined will depend the gravity or otherwise of the disease. [H. L.]

Alchemilla, a genus of plants of the Rose family. See Lady's Mantle.

Alcohol is the name given to the active principle of intoxicating liquors, and is obtained by the fermentation of sugar. Starch forms one of the principal sources of sugar for this purpose, owing to the readiness with which it can be converted, either by the action of diastase, or by boiling with a mineral acid into a fermentable sugar. In the United Kingdom the materials used for the production of alcohol are malt, maize, barley, oats, rice, and molasses; in fact, any plant material containing sugar or starch may be used. In the United States, corn (maize), rye, and molasses are mostly used; in Germany, potato starch; in France, beet sugar and molasses.

To obtain alcohol the product from the fermentation of sugar which contains from 10 to 14 per cent of alcohol is distilled, the impure alcohol coming over as a colourless liquid and forming what is called crude spirit. It is purified from other bodies by further distillations, when it is called rectified spirit. This contains about 91 per cent of alcohol, the rest being water, with a trace of fusel oil. Absolute alcohol is quite free from water and any other substances.

Intoxicating liquors, such as whisky, brandy, gin, rum, liqueurs, &c., are all manufactured from the distillate obtained from fermented sugars, the active constituent in each case being alcohol; indeed beer and any kind of wine will yield alcohol on distillation. The alcohol is called spirits of wine. Another alcohol may be obtained by distilling wood, and is called wood spirit, methyl alcohol, or wood naphtha. It has very similar properties to spirits of wine, but possesses a disagreeable flavour, for which reason it is not used in beverages.

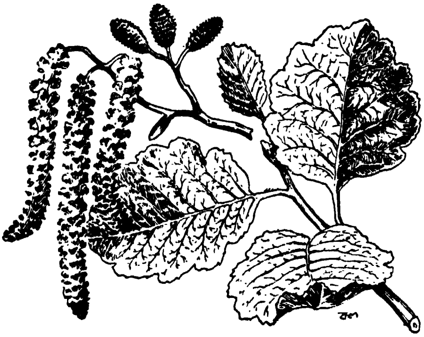
Alcohol present in beverages such as whisky, beer, &c., is, for revenue purposes, subject to a high tax by the Government. Its production is under the supervision of the Inland Revenue authorities, whose duty is to gauge the amount of alcohol present in crude spirit and in different grades of rectified spirit. The crude spirit as it comes from the still is conveyed to large storage tanks situated in the Government bonded warehouses. From these tanks it is run into new barrels the capacity of which is known. The strength of the spirit having been gauged by a revenue official, each cask is then taxed according to the amount of alcohol present. As the spirit matures, the amount of alcohol slightly decreases. Proof spirit has a specific gravity of ·920 at 15·6° C., and contains 49·24 parts of alcohol to 50·76 parts of water by weight, or 100 volumes of alcohol to 81·82 volumes of water. The strength of the spirit in the cask is thus expressed as being either above or below proof, whichever it happens to be.

Industrial Alcohol, Methylated Spirits, Denatured Alcohol. — Besides the use of alcohol in beverages, it is extensively used for manufacturing and other purposes; for this reason only it forms a very important article of commerce. The alcohol utilized in this way is not subject to a Government tax, and is therefore duty free, otherwise a tax would cripple many industries in which alcohol plays an essential rôle.

Industrial alcohol is ordinary spirits of wine, to which has been added substances imparting to it a very unpleasant and disagreeable taste. The addition of these substances is called denaturing. This makes it unfit for consumption or use in the preparation of beverages, but does not interfere with its utilization for industrial purposes. The substances generally added are methyl alcohol, benzine, pyridine, &c., but they are determined by the commissioner of the Inland Revenue. The particular substance used in denaturing alcohol depends to some extent upon the ultimate use to be made of the spirit. Pure alcohol is cheaper than brandy, rum, &c., for which reason it is sometimes added to these liquors. Denaturing, however, prevents its use for that purpose. The process of denaturing is entirely in the hands of the Inland Revenue authorities, and the resulting industrial alcohol is stored in the Government bonded warehouses. In the manufacture of alcohol by distillation of the fermented liquor it is not found practicable to purify the alcohol from the whole of the distillate obtained, the quantity amounting to from 10 to 15 per cent. This portion, though it is unsuitable for mixing with beverages, is nevertheless sometimes employed in the preparation of low-class spirits. It is, however, suitable for industrial purposes, and after denaturing is made use of in that way.

Uses of Industrial Alcohol.—Denatured alcohol is a good solvent for oils and resins, and is extensively used in the preparation of varnishes, coal-tar dyes, transparent soap, ether, collodion, artificial vinegar, white lead, &c.; in pharmaceutical preparations, and for preserving anatomical specimens; in the manufacture of smokeless gunpowder, and in many other industries. Perhaps one of its most important uses is for illuminating and heating purposes in the household. It would be suitable for use in motors, but its cost compared with mineral oils prohibits its utilization for that purpose.

[R. A. B.]



Common Alder (*Alnus glutinosa*)

Alder (Alnus), a genus of the sub-ord. Betulaceæ (nat. ord. Amentaceæ). Fourteen species are known as small trees or shrubs indigenous to temperate and cold regions, and of these eight are found in Central and Western Europe. The only species indigenous to Britain is the Common Alder (*A. glutinosa*), which grows abundantly on woodland swamps, in wet woods and pastures, and along the margins of streams, and which extends eastwards across the whole of Central Europe into Western Asia below the arctic circle. Growing singly or in open groves it seldom exceeds about 40 ft. in height; but if drawn up in close canopy, especially on a good loamy soil and mixed among other trees, it can attain a height of 50 or 60 ft., with a fair proportionate girth. The leaves are smooth and sticky (hence the specific name), stalked, broadly ovate or orbicular, sharply toothed, and occasionally lobed. The two or three terminal catkins, which appear early in spring before the leaves flush, are grouped in small clusters or panicles: and in the small, ovoid, fruiting catkin the ligneous scales somewhat resemble those of a miniature blackish-brown pine cone, especially after they have opened and shed the seed. The only other two introduced species frequently found growing as ornamental trees in Britain are the White or Grey Alder (*A. incana*) of continental Europe and North America, with non-glutinous acute leaves, downy beneath, and the Cut-leaf Alder (*A. laciniata*), with narrow, deeply-incised foliage; but the rarer Golden Alder (*A. aurea*), with bright-yellow leaves, and the Italian Alder (*A. cordifolia*), with heart-shaped, acuminate foliage, are also fairly hardy in most parts of Britain. The Common Alder is the only species here cultivated for profit, and the old 'alder-mores' or groves on moorish spots and marshy tracts (occurring extensively in the New Forest, for example) were formerly of considerable importance for the preparation of charcoal for gunpowder. Its orange-yellow to light-reddish, cedar-like wood (sp. gr. 0·83 green, 0·54 seasoned) is soft, and soon rots or becomes worm-bored unless used entirely under water, when it is very durable, and this makes it specially useful for underground portions of bridges, pumps, sluices, &c. Its durability in or above the ground is increased by barking, to allow the sap to evaporate quickly. Alder is still largely used in gunpowder manufacture, and also in clog-making, and for herring-barrel staves, wood-pulp, turnery and joinery, while the brushwood is fagoted for kindling purposes. Both the leaves and the astringent bark contain tannic acid and have dyeing properties, which are utilized on the Continent. Although thriving best on sandy loam and in humid, low-lying localities, yet it grows freely on almost any porous, moist, or wet soil, for it is hardy against frost; but of course it does not do so well in water-logged tracts, where the moisture in the soil and subsoil is stagnant and highly impregnated with humic and other acids. It coppices well, throwing up a good flush of clean, straight stool-shoots and also of suckers (especially on peaty land) from its long thin root-strands, which it throws out plentifully in lateral directions in place of forming any deep taproot. It is worked throughout Britain almost entirely as coppice, with a rotation varying locally from about ten to twenty-five years, according to the most profitable size of pole required; but in East Prussia and West Russia, where its wood is in good demand for cigarboxes, the coppices are often cut over only every thirty to forty years, or else it is grown in mixed highwoods and thinned out at from fifty to eighty years of age. From about fifteen to twenty years onwards it produces seed freely every second or third year, which ripens in October and is gradually shed from the catkins. If seed be wanted, ripe catkins can then be gathered, stored in a dry place, turned over from time to time, and the seed issuing sown in March with only a very slight soil-covering. One pound contains from 300,000 to 360,000 seeds, but the germinative percentage is very low. The seed is sown broadcast on beds. The seedlings are from 8 to 10 or 12 in. high by the end of the first year, and are fit for use as sturdy plants after standing in the nursery transplant-lines for two or three years; they bear transplanting well. But thin coppices can also easily be improved by felling low and by interplanting with cuttings or with severed suckers, which spring up more freely if surface-rootstrands are partially laid bare here and there. The Alder has no dangerous enemies, its bitter astringent bark even protecting it fairly well against the voracious rabbit. Stems are bored into and shoots gnawed by *Cryptorynchus lapathi*; canker is caused by *Nectria ditissima*, and red rot in the stem by *Polyporus sulphureus*; but on the whole it suffers little from insects or fungous diseases. (See next article.)

[J. N.]

Alder.—Parasitic Fungi.—Wood Rot.—The common Red Rot of the timber is generally put down to the action of the Sulphur Polyporus (*Polyporus sulphureus*). White Rot has been traced to another of the same family (*P. igniarius*). These and other forms of heart rot are most likely to occur in old trees, and may be regarded as a hint to remove them so as to allow younger and more vigorous ones to take their place. This is advisable even when the Alder is of little value, since the decayed stems only act as nurseries for fungi which may attack more valuable timber or fruit trees.

Death of Twigs and Leaves.—Nursery stock may be damaged through the premature fall of leaves and death of young twigs. *Valsa oxystoma* has been recorded as destructive in this way in the Alps, where Alder leaves are collected and dried for winter fodder.

Deformed Catkins.—A malformation of the catkins accompanied by non-development of seeds may follow on the attacks of fungi.

Exoascus alni-incanæ, one of that group of Ascomycetes, causes curious reddish tongue-like outgrowths from the catkins, and *Sclerotinia alni* accompanies a drying up of the catkins.

Treatment.—No reliable accounts are available, but, if necessary, spraying with Bordeaux mixture would check leaf-spotting and the catkin fungi. [W. G. S.]

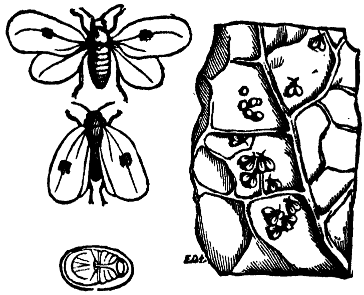
Alderney Cattle.—The term 'Alderney' was formerly applied indiscriminately to all cattle that were brought into this country from the Channel Islands, and even from Normandy and Brittany, including what are now separately distinguished as the Guernsey and Jersey breeds. (See arts. on Guernsey and Jersey.) This collective application of the term Alderney is not now recognized, but in the island of that name there still exists a relatively small number of cattle which are known as Alderneys. At one time these closely resembled the Jerseys, but by crossing with Guernsey bulls they have become larger in frame and coarser in build. They form excellent dairy cows, and share with the Jerseys and Guernseys the capacity for butter production for which the latter breeds are famed. [J. B.]

Aleochara.—A genus of minute rove beetles found in rotten turnips, giving them what is termed a "grubbed" appearance. They are bred amongst the putrescent parts of the roots, where the larvæ feed, and sometimes are very numerous, forty or fifty having been found in October in the crown of a single turnip.

[J. C.]
[F. V. T.]

Aleurone is the term applied to certain organized granules found in seeds and some fruits. The albuminoids which form the principal material of the granule exist both in a crystalline and amorphous state. Besides the nitrogenous content, the remainder of the granule is filled with oil globules and vegetable mucilage. They form a concentrated food supply for the young plant on germination of the seed. [R. A. B.]

Aleyrodes brassicæ, &c.—Aleyrodes is a genus of insects belonging to the Hemipterous family Aleyrodidæ, related to the Scale Insects and Aphides. They are popularly known as snow, ghost, and white flies. In some seasons the cabbages, broccoli, &c., are smothered with *Aleyrodes brassicæ*, especially from midsummer to the close of autumn, when myriads of these little white insects start off the leaves when disturbed, making short flights. On the snowy-white upper wings are four faint smoky spots; they have two short antennæ, six legs, and a beak similar to the Aphides. They frequent and breed on the under side of the leaves. The female lays her eggs in a circle, or in scattered groups of from five to twenty. They are very minute, smooth shelled, and elongate oval in form, attached to the leaf by a short stalk at the broader end of the shell. In colour they vary from white to pale-green and bluish-black. They hatch in from ten to fifteen days. The young larvæ, wrongly called nymphs, hatching from the ova are oval in form, with six ill-defined legs and caudal setæ. They become nymphs or pupæ attached to the foliage, and are then covered with a peculiar skin, looking like the scale of one of the Coccidæ. In this case the nymph matures, and the adult snow fly escapes from the shell. Several species occur in Britain, both in greenhouses and in the open. *A. vaporarium* (Westwood) is a pest on chrysanthemums, cucumbers, tomatoes, &c. Spraying with soft soap and quassia is the best treatment out-of-doors; fumigation with hydrocyanic acid gas under glass. [F. V. T.]



Snowy Fly (*Aleyrodes brassicæ*)

Fly and pupa, much magnified; flies on leaf, twice nat. size.

Alfalfa.—Another name for the leguminous plant more generally known in Britain as Lucerne. Either in the green state or as hay it forms a very valuable fodder crop. See Lucerne.

Algæ.—All plants of lower organization than mosses are usually placed in one large group—the Thallophyta, the members of which show no differentiation of body into root, stem, and leaves, such as is usually met with in the higher plants. This group is subdivided into two classes, Algæ and Fungi, the former possessing the green colouring matter chlorophyll, which is absent from fungi.

Taken as a class the Algæ are of simple structure and inhabit the sea, or live in fresh water, or on the surface of damp walls, rocks, the bark of trees, and in similar moist situations. They are either some shade of bluish-green, green, brown, or red colour, the four several tints enumerated being characteristic of the following four sub-classes into which the Algæ are divided, viz.:—

The Blue-green Algæ, or *Cyanophyceæ.*
The Green Algæ, or *Chlorophyceæ.*
The Brown Algæ, or *Phæophyceæ.*
The Red Algæ, or *Rhodophyceæ.*

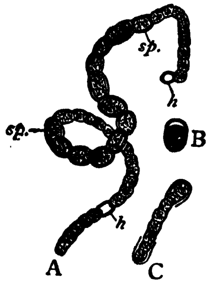


Fig. 1.—*Nostoc Linckii*

A, Part of a filament; *h*, *h*, heterocysts; *sp*, spores. B, Isolated spore beginning to germinate. C, Young filament formed from a spore, the burst cell-wall of which is shown at the ends. × 470 (after Bornet).

1. The Cyanophyceæ contain in addition to chlorophyll a blue colouring substance termed phycocyanin, which can be extracted with water. The plants are very simple structures, being either single isolated cells or cells united into long filaments or flat plates. The cell walls are often mucilaginous. Vegetative reproduction is brought about by simple division of one single cell into two, and subsequent repetition of the process, in a manner somewhat similar to that seen among bacteria, to which they appear to be related. Spores are produced. These are single, thick-walled cells, which germinate under favourable conditions and grow into new individual plants. Sexual reproduction is unknown. The blue-green Algæ are common both in sea and fresh water, and are met with in slimy, blue-green masses in water pipes, muddy ponds and ditches, and on tree stems and wet rocks. Some of them live a semi-parasitic life in the interior of other plants.

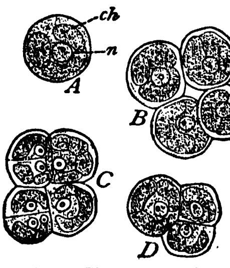


Fig. 2.—*Pleurococcus vulgaris*

A, Single cell; *n*, nucleus; *ch*, chloroplastids. B, Four cells separating after division. C, Group of cells remaining in contact. The two to the left have just divided afresh. D, Tetrahedral group. × 540 (after Strasburger).

2. The Green Algæ, or Chlorophyceæ, are plants most abundant in fresh water, and on trees, stones, and damp earth, although a few representatives are found in sea water.

The body of the plants is of simple structure, either a single cell or rows of cells forming elongated threads, which may be branched. Some are formed of collections of cells in the form of flat plates. A very common example of the simplest type is *Pleurococcus vulgaris*, which appears as a green powder or slimy mass on flower pots, the bark of trees, and other objects. The plants, which are single round cells, in this case multiply solely by division of the cell. Sexual reproduction does not occur. (Fig. 2.)

Two species which are common, in the form of green, slimy, hair-like material, in ponds, drinking troughs, and slow-running streams, are *Spirogyra communis* and *Ulothrix zonata.* Both have long, thread-like bodies of cells placed end to end. The latter is reproduced asexually by means of motile zoospores, each of which possesses four cilia. These swim about for an hour or two, then settle down, and from them a new plant filament is developed. (Fig. 3.)

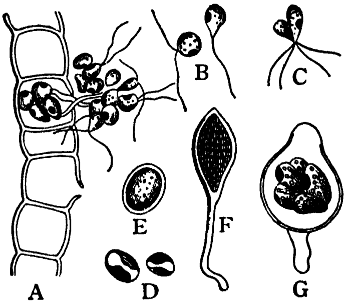


Fig 3.—*Ulothrix zonata*

A, Part of a filament; most cells already empty; from one the biciliate zoospores are escaping. B, Zoospores. C, Two in the act of conjugating. D, Two young zygospores, immediately after conjugation. E, Ripe zygospore. F, Unicellular plant grown from zygospore. G, Similar plant producing zoospores, which are about to escape. × 482 (after Dodel. Post).

Sexual reproduction also occurs. The sexual cells are motile, biciliate, and smaller than the preceding. They fuse in pairs, and give rise to a spore (zygospore), which germinates, and after remaining in a resting state for a time, finally grows into a new plant.

In Spirogyra no special asexual process of reproduction is known, but sexual reproduction takes place by means of a zygospore, which is produced by the fusion of the protoplasm from two cells of neighbouring filaments.

A group of single-celled Algæ, the Desmids, common in fresh water, are often included in this group. They are minute and of beautiful form. Reproduction by division is frequent, and the production of zygospores by the fusion or conjugation of two similar individuals is characteristic.

The Stoneworts, or Characeæ, which are found in streams and ponds, are sometimes placed among the Green Algæ, although in some respects they show little relationship to others in this group. Their stems and whorls of branches are frequently encrusted with a deposit of calcium carbonate, giving the plants a brittle, harsh character. Their sexual reproductive organs are peculiar and complex in structure. From the male organs or antheridia arise spermatozoids, which find their way to the egg-cell in the female organ or oogonium.

3. The Brown Algæ, or Phæophyceæ, are almost entirely marine. They contain in addition to chlorophyll a brown or yellowish-brown colouring substance, phycophæin.

A few species are small and of simple structure, but the majority of them are large seaweeds, the bodies of which are differentiated into a root-like structure which attaches the plant to rocks and stones, and a stem bearing flattened leaf-like organs, in many cases somewhat resembling thin rubber or leather. Many are found growing on the seashore between high- and low-water mark, being covered for a time each day with sea-water.

Laminaria digitata is a common species in northern temperate regions. It possesses a well-developed root-like holdfast, with a cylindrical stem ½ inch thick or more, and a flattened leaf-like portion slit into four or five ribbons.

Several common species of Fucus or bladder-wrack are met with on the seashore. The stem-like parts of the plant are branched. Upon them here and there are bladder-like cavities full of air, which enable the free parts to float readily in the water.

In some of the Brown Algæ asexual reproduction occurs, minute motile zoospores being produced which, after swimming about for a time, settle down and germinate, ultimately growing into new plants.

In Fucus and many other species sexual reproduction is common. The sexual organs are developed in hollow cavities or conceptacles, which are generally produced on specially modified branches of the plant.

The male sexual cells are biciliate, motile spermatozoids; the female cells (egg-cells or oospheres) being round and non-motile. Both are set free into the sea water, and fertilization of the egg-cells by the spermatozoids occurs when they are free from the parent plant.

4. The Red Algæ, or Rhodophyceæ, are a very large and distinct group whose relationship to the other Algæ is obscure.

Some of them are found in fresh water, but the majority inhabit the sea. One of these is Irish Moss or Carrageen (*Chondrus crispus*), which contains a gelatinous substance, and is used as food on the west coast of Ireland. The gelatinous agar-agar, much used in the preparation of bacteriological media, is obtained from species of Red Algæ. The colour of those commonly met with in sea water is some shade of red, pink, or purple, the colouring matter being a rose-red substance, phycoerythrin, which is present along with chlorophyll in the cells of the plants.

Non-motile asexual spores are produced. These grow into new plants under favourable conditions.

The sexual organs are of peculiar structure, quite different from those of the Algæ belonging to the previously mentioned groups. The male cells, or spermatia, are non-motile, and round or oval. The egg-cells are produced in a special organ, the carpogonium, whose apex is prolonged into a thin, elongated structure, the trichogyne. In the process of fertilization the spermatium is set free and washed into contact with the receptive tip of the trichogyne, its protoplasm being transferred and ultimately fused with the egg in the basal part of the carpogonium.

Some of the marine Algæ are of importance in agriculture, being largely used for manurial purposes. See article *Seaweed.*

[J. P.]

Alimentary Tract, The.—Commencing at the mouth and terminating at the anus, the digestive canal should be considered as a whole, with particular functions allotted to its several parts. Its total length in the horse is about ten times that of the body; mouth and pharynx, 1 ft.; gullet, 3 ft.; stomach, 2 ft.; small intestine, 72 ft.; large intestine (cæcum, large and small colon, and rectum), 26 ft. The ox and sheep, being ruminants, have four so-called stomachs or separate compartments of what in single-stomached animals would be regarded as dilatations of the alimentary canal. The weight of the stomach and intestines of the ox is estimated at rather more than 14 per cent of the animal. Digestion is therefore more complex and liable to disturbing elements than is the case in animals built for speed and labour rather than for assimilation of large quantities of food to be converted into fat. The horse is provided with incisor teeth in both upper and lower jaws with which to seize his food. Ruminants have only those in the lower jaw, as the tongue is the organ of prehension. The mouths of all animals are provided with glands whose office it is to pour out saliva to mix with the food during the act of mastication. Besides certain salts, the fluid contains a ferment (ptyalin), and in the mouth is begun the first stage of digestion. Many digestive troubles are due to failure at this stage by reason of defective teeth, and other causes to be referred to elsewhere. The gullet is a musculo-membraneous tube which, receiving a stimulus from the pharynx when a pellet of food reaches it, contracts upon the morsel and conveys it to the stomach. Its lining membrane is very tough, and lies in folds when not engaged as a conduit. The stomach of the horse, and that of the pig, has a greater and lesser curvature, and is relatively small as compared with that of ruminants. The lining membrane is divided into a villous and a cuticular portion, and is provided with glands whose office it is to secrete those gastric fluids which carry on the process of digestion commenced in the mouth. The entrance into the stomach is known as the cardiac orifice, and the exit into the small intestine as the pyloric. In the small intestine are found Peyer's and Brunner's glands, and here also the ducts of the liver and pancreas have their mouths, pouring their products into the canal to mingle with the ingesta and play their very important parts in the process of digestion. As the contents of the bowel pass along by the contractions of its muscular coats, the prepared portions are taken up by the lacteal vessels, and pass thence into the circulation of the blood to nourish the animal. They are fewer in number as the rectum is approached, this straight or terminal portion acting as a convenient accumulator for the undigested or waste material, from whence it is ejected from time to time. See arts. on Digestion, Intestines, Stomach, &c. [H. L.]

Alinit.—A culture of a nitrogen-fixing bacterium used for inoculating soils. See Inoculation of Soil.

Alkalis.—This term is applied to an important class of chemical substances. Originally the name was given to the property possessed by the ash of plants, and designated fixed alkali, as marking a distinction from ammonia, which was termed volatile alkali. The substances now included under the heading are compounds formed by the union of metals with oxygen, called oxides, and hydroxides when the oxide is in combination with water. Strictly speaking the alkalis are generally understood to be the oxides and hydroxides of the alkali metals, the more important of which are sodium and potassium. Closely allied to these metals are those of the alkaline earths, namely, calcium, magnesium, &c., which form compounds with oxygen and with water very similar to those of sodium and potassium. For that reason they are included here under the term.

Alkalis have the power of neutralizing acids, forming salts. This property is called basic, and just as there are strong and weak acids, so we find that some alkalis are more basic than others. A strong base can replace a weak one from its combination with an acid; thus lime, being more basic than ammonia, substitutes the latter, which is given off as a gas from its combination with an acid.

They impart a soapy feeling to water, and turn the red vegetable colouring matter litmus, blue. Generally they are of a caustic nature. When left exposed to air they absorb water vapour and carbon dioxide, forming respectively a hydroxide and carbonate. Thus lime slowly parts with its basic properties in contact with air, because the carbonate finally formed is a neutral salt. Though chalk or calcium carbonate is a salt, it can, because of the feeble acid properties of the carbonic acid of which it is partly composed, act, in presence of a stronger acid, as a base. When chalk is added to a sour soil the vegetable acid in the soil combines with the lime in the chalk by replacement of the carbonic acid, forming a salt, the carbonic acid being given off as a gas. An alkaline substance is one possessing the property of an alkali.

The principal alkalis of mineral origin important in agriculture are: lime (CaO), magnesia (MgO), potash (K_2O), soda (Na_2O). In addition to these there is the well-known substance ammonia, a compound of nitrogen with hydrogen, and possessing very powerful basic properties (see Ammonia, Lime, Magnesia, Potash, Soda).

Besides these there are others of a very complex nature which should be mentioned. They occur in vegetable and animal tissues, where they play an important part in the metabolic processes associated with animal and vegetable life.

Quicklime is the only alkali extensively used in agriculture. As quicklime it is most basic, as slaked lime less, and as chalk least. When in the caustic state it is injurious to plant life, but after spreading on the soil it soon loses its caustic property. Magnesia, on the other hand, only slowly loses its caustic nature under the same conditions, hence its presence in a sample of quicklime is undesirable. Quicklime combines with water, forming slaked lime, and a solution of lime in water is called lime water. Potash and soda are of great commercial value, being an essential reagent in use in many manufacturing processes, veterinary science, &c.

The above-mentioned alkalis are all found in the ash of plants in combination with acids or salts. Those of mineral origin, that is, formed by the combination of a metal with oxygen, are non-volatile, hence the term 'fixed alkali' at one time applied to them. [R. A. B.]

Alkali Soils are soils containing excessive quantities of soluble sodium, potassium, and other salts. They occur in the belts of low rainfall which lie some distance north and south of the equator, including the south-westerly portion of the United States, North Africa, North-west India (the Punjab and the United Provinces), and parts of South America, of South Africa (the Kalahari Desert), and of Australia. Hilgard has fully investigated the alkali soils of the United States, and embodied the results in his book entitled Soils, and the 'usar' lands of India have been dealt with by the 'Reh' commission of 1876 and by Leather (Agric. Ledger, 1897 and 1901).

Most plants fail to grow on these soils, and the aspect of the country is very desolate. Frequently, however, the trouble is quite local, only isolated patches are affected, and a luxuriant growth is obtained elsewhere. The barren patches may spread and move about in a remarkable way, especially on irrigated land, and once 'alkali' appears the whole field is in danger. The typical alkali soils are found on large plains or in valleys; hills are, as a rule, free.

The affected soil usually contains 0·1 to 3 per cent of soluble matter, calculated to a depth of 4 ft., corresponding to 4000 to 120,000 lb. per acre in each foot, but the distribution varies considerably at different times. After heavy rain the soluble matter washes down, but by the end of the dry season it has largely accumulated in the top 6 or 8 in., and frequently appears as an efflorescence. It consists mainly of sulphates, chlorides, often carbonates, bicarbonates, and nitrates of sodium, calcium, often potassium and magnesium (Hilgard, Soils, p. 442). The carbonates of sodium and potassium are directly injurious both to the soil and the plant. They deflocculate the clay, and make the soil sticky and unkindly. They are fatal to plants, seedlings die off rapidly, and the root-crown of established plants is corroded, becomes brownish, and finally the plant dies. Some of the organic matter of the soil is decomposed, forming dark-coloured substances, hence the name 'black alkali' is applied to soils containing much sodium or potassium carbonate. The other salts are not injurious themselves, but only by reason of the excess; if carbonates are absent, or nearly so, the corroding effect is not seen, plants stand better, and the efflorescence is called 'white alkali', although the soil may not be alkaline at all.

There is usually a fair amount of lime; 'black alkali' soils contain only little nitrate, but an appreciable quantity of ammonia; in 'white alkali' soils the amount of nitrate is greater, and may be as much as 20 per cent of the soluble salts.

It is generally supposed that these salts are formed by the breaking up of rocks and minerals into simple, soluble compounds, a process always going on in all soils, and contributing largely to fertility in ordinary cases. In humid regions the amount of soluble matter in the soil is limited by the rainwater washing away certain sodium, calcium, and other compounds; but in the dry regions where alkali soils occur no washing-out takes place, and soluble matter is produced at a faster rate than it can be removed. An alkali soil, in fact, contains excess of plant food.

Cameron (Bull. 17, U. S. Bureau of Soils, 1901) considers that all the characteristic alkali substances can be accounted for by the interaction of sodium chloride (salt) with calcium sulphate, calcium carbonate, and magnesium carbonate, bodies known to be present in most soils. He distinguishes three types in which the chief reactions are:—

1. Sodium chloride + calcium sulphate $\rightleftarrows$ sodium sulphate + calcium chloride.

2. Sodium chloride + calcium carbonate in presence of carbon dioxide $\rightleftarrows$ sodium carbonate + calcium chloride.

3. Sodium chloride + calcium carbonate + calcium sulphate $\rightleftarrows$ sodium carbonate + sodium sulphate + calcium chloride in varying amounts.

The arrows indicate that the change is reversible and may go in either direction. The third type is the commonest. Magnesium carbonate behaves like calcium carbonate. These reactions may take place in every soil, but if there is sufficient rain to wash out the sodium chloride they only proceed to a slight extent. In the typical case the salts are formed *in situ*, but it not uncommonly happens that additional soluble matter is brought down from higher land by seepage water.

The distribution of the alkali in the soil is a vitally important matter, and is closely connected with the movements of the soil moisture. Much evaporation from the surface of the soil causes the salts to travel upwards, and soon kills the vegetation; where evaporation is checked the salts are more widely distributed, or occur at lower depths, and have less effect. Water lying in the ground and evaporating at the surface is particularly harmful: it dissolves out the salts from a considerable bulk of soil, and concentrates them in the upper layers. Irrigation is a necessity in these regions, but irrigation badly carried out, with leaky ditches, excess of water, and no under-drainage, has been responsible for an enormous amount of damage in the United States, in Egypt, and elsewhere. It is now clearly recognized that irrigation and drainage must go together (see Scott-Moncrieff, Brit. Assoc. Reports, 1905, and also Major Hanbury Brown's Reports on Irrigation in Egypt).

Land prone to alkali may be kept productive by suitable management. During the dry season evaporation must be checked by constant cultivation, irrigation water only used sparingly, and drainage introduced. At the end of the season the top layer of soil, which contains an enormous amount of the salts, may be scraped off, or else buried some distance below the surface by trenching. Sodium and potassium carbonates are the only substances directly injurious to plants, and they are decomposed by gypsum to form sulphates, which are harmful only in excess, and calcium carbonate, which is beneficial to the plant, and helps it to overcome the effect of excessive saline matter. Hilgard has shown that the change is reversed if much carbonic acid is present; thorough aeration of the soil is therefore necessary. In absence of sodium carbonate, dressings of gypsum are of no use. Only suitable crops should be grown. Plants vary greatly in their sensitiveness to alkali. Grease-wood (Sarcobatus), the Australian saltbush (*Atriplex semibaccata*), alkali grass (Distichlis), and the Chilian *Modiola procumbens* are extremely tolerant; while sunflower, lucerne, melilot, sorghum, millet, rye grass, tussock, olives, date palms, almond, and sycamore all stand a good deal. Cereals will tolerate about ·1 per cent of sodium carbonate, ·25 per cent of sodium chloride, ·5 per cent of sodium sulphate on a sandy soil, but less on clay. Beets stand more; but clover, beans, &c., are very sensitive.

Alkali land may be reclaimed by first treating with gypsum if sodium carbonate is present, then underdraining and flooding to wash out excess of soluble matter. This method is said to have given wonderful results in the United States (see Hilgard, Soils, p. 455), and the reclaimed land is very fertile. [E. J. R.]

Gypsum, in heavy dressings, has been successfully employed in the reclamation of black alkali lands in America. Hilgard has shown that when it is added to a soil containing alkaline carbonates a favourable reaction takes place, under conditions of good aeration. The alkaline carbonates are converted into the corresponding and comparatively harmless sulphates, and at the same time the useful ingredient carbonate of lime is produced.

On the other hand, if excess of carbon dioxide or of supercarbonates is present in the soil, the conditions are favourable for the reverse reaction, and the addition of gypsum does no good at all. These reactions indicate that whenever gypsum is added to the land, aeration should be promoted by drainage, if necessary, and by good cultivation. The gypsum treatment does not beneficially affect white alkali soils, nor is it even, in the case of black alkali, a complete remedy. Hilgard, to whose researches we owe most of our knowledge of alkali soils, advocates flooding with irrigation water in connection with thorough under-drainage as the best treatment for alkali conditions. [G. A. J. C.]

Alkanet, a name given to two species of plants of the natural order Boraginaceæ. The Common Alkanet (*Anchusa officinalis*) is found in a few localities in Britain, chiefly on the east coast of England. For the Evergreen Alkanet see ANCHUSA.

Alliaria.—Common Alliaria or Garlic Mustard is a Cruciferous plant associated with the genus Sisymbrium. See SISYMBRIUM.

Allium.—A genus of Liliaceous plants comprising garlic, the onion, leek, shallot. See GARLIC.

Allotments.—An allotment for statistical returns has been taken by the Board of Agriculture as a plot of land not exceeding 1 ac., and this was the definition given in the Allotments Act of 1887 and in the Allotments (Scotland) Act, 1892. But the Local Government Act of 1894 authorized the letting of 'an allotment or allotments' up to the area of 4 ac. to one person, while the Small Holdings and Allotments Act of 1907 definitely extends the limit of an allotment to 5 ac. The distinction between allotments and small holdings, therefore, has been obliterated, at any rate as far as England and Wales are concerned. County Councils will let plots of 1 ac. to 5 ac. as small holdings, and Parish Councils will let them as allotments. No return of the number of allotments not exceeding 1 ac. has been obtained since 1895, when it was put at 579,133 for Great Britain. This number was greater by 124,128 than it was in 1890, showing an average increase of 24,825 per annum. If it might be assumed that there has been an equal annual increase in the last twelve years, the present number of allotments not exceeding 1 ac. in Great Britain would amount to 877,033. In 1906 the number of holdings over 1 ac. and not over 5 ac. was 109,749, which, added to the smaller allotments, would make a total of 986,782. It is doubtful, however, whether the increase in allotments of 1 ac. or less has continued since 1895 on the scale indicated between 1890 and 1895, and it is quite time for a fresh return to show the present total, which is only a matter of conjecture. The distribution of allotments not over 1 ac. in 1895 differed greatly in the main divisions and counties of Great Britain in proportion to total agricultural areas. In Scotland there were only 9237, as compared with 13,274 for Wales and 556,622 for England, while the county figures were equally disproportionate.

Evidence obtained in recent public enquiries bearing upon the subject is to the effect that the supply of allotments is equal to the demand in most parts of England. In some counties or districts, however, this is not the case, and in many more it is true only because the demand has been restricted by unfavourable conditions, such as high rents, inconvenient situation, or unsuitable soil. Apart from these drawbacks, moreover, the demand for allotments is influenced by various circumstances. As they are usually cultivated by men who work regularly for wages, with or without the help of their families, the demand for them, particularly among agricultural workmen, is less where the proportion of ploughmen and attendants upon live stock is large than where it is comparatively small, because such men have very little spare time before or after their daily hours of employment for hire. The demand is also less where men are boarded in farmhouses or bothies than where they live in cottages and board themselves; and it is also found that those who earn comparatively high wages are less desirous of allotments than men who are badly paid. These considerations explain, at least partly, why the number of allotments in proportion to the total agricultural area or the population is much smaller in Scotland than in England.

Some years ago the proportions of allotments in different counties to the population varied so enormously that in a comparison of only six the ratio of detached allotments to the total number of people of all ages ranged from 1 to 9·7 to 1 to 80·7. The allotments were exclusive of garden allotments attached to cottages and ordinary cottage gardens. Probably the differences are smaller now, though they were great when the last official return of the number of allotments was issued, in 1895. It is hardly necessary to state that where cottage gardens are large or of fair size the demand for allotments is comparatively small. The general opinion among men of experience is that it is not profitable for a workman to take in hand more land than he can manage, with the help of his family, without losing wage-earning time. The limit depends upon whether the land is arable or in grass; but plots called allotments hitherto have been arable almost exclusively, for those which are in grass are named either cow plots or small holdings. Whereas a man working regularly for wages cannot attend properly to more than a quarter of an acre of arable land in his spare time, or half an acre with the help of able-bodied members of his family, he can manage 3 to 5 ac. of grass land without losing any considerable time from his regular employment. It is true that, in rural districts, there are many allotments of an acre or more; but these are partly cultivated by horse labour, and their holders have to get leave of absence from their regular employment for a few days occasionally.

A large proportion of the allotments in Great Britain is that of those which are to be found in the neighbourhood of towns. These small plots of land are really needed more by town workmen than by agricultural labourers, as few of the former have gardens of any considerable size, if any at all, while the latter usually have ground enough attached to their cottages for growing the vegetables they require. There are, however, numerous exceptions, as not a few houses in some country villages are devoid of gardens, or of any ground more extensive than a small backyard. Single men, too, who are only lodgers, often take allotments, in order to grow vegetables, fruit, or flowers for sale.

As a rule, the crops grown on allotments are mainly those of culinary vegetables, though strawberries, bush fruits, and flowers are grown to a limited extent. It is seldom that fruit trees are planted in allotments. In many instances landowners or allotment associations prohibit such planting, and where this is not the case occupiers are deterred from planting trees by several objections. In the first place, an allotment holder is often a workman who may be in one place to-day and in another a year hence. Secondly, there is not sufficient security for money invested in fruit trees and their rearing, and, if there were, it is not desirable to have a heavy sum in tenant right on a plot of land which a man may take for only a year. There is also to consider the great risk of having fruit stolen, if it is grown where many people, including children, have access to it, as they have in a field divided into allotments. A man who desires to grow fruit should take a small holding, separate from other holdings, either purchasing it or hiring it under the Market Gardeners' Compensation Act. Very few landowners hitherto have been willing to let land under that Act, because it would have rendered them liable to an indefinitely large amount of compensation to an outgoing tenant. In England and Wales, however, under the new Small Holdings and Allotments Act, occupiers under the County or Parish Councils will be entitled to claim compensation under the Act for any improvements to which it relates, unless specially prohibited from making such improvements, and even then entitled to appeal to the Board of Agriculture to overrule the prohibition. In the Evesham district many a man has started as a fruit grower by hiring and planting a single acre of land; but then the Evesham custom entitles a tenant to sell his tenant right to his successor, so that he has complete liberty in making improvements, and the best possible security, without rendering his landlord liable to anything.

The rents of allotments vary greatly. On most of the large estates they are low or moderate in the rural districts, usually from 20*s.* to 40*s.* per acre, including rates. But near towns, or even close to some villages, they are very high, often from £4 to £8 per acre. Land near towns is usually let by the perch, and the rates per acre are worked out at the perch rates. Many of these urban allotments are only 10 to 20 ps. in extent, and there are places where land is absurdly let by the hundred square yards, as in some parts of the Midlands of England, and where that area, barely $\frac{1}{48}$ ac., constitutes an allotment. The land near towns is what is called ‘accommodation land’, and it commands high rents even if let in considerable quantities; but it should be the property of municipalities, instead of that of speculative holders, in order that it may be let on moderate terms for allotments or sold on like terms for building purposes. The demand for allotments is often checked by the highness of the rents demanded, or they are tried at such rents, and afterwards given up as unremunerative. Instances of land near country villages, belonging to small owners, rented at the rate of £3 or even £4 per acre are to be found. In other cases the field devoted to allotments near a village is one of stiff clay, which is quite unsuitable to spade husbandry.

Owners of allotments in many districts complain of loss of rent and of plots being thrown on their hands in a foul and exhausted condition. But in the great majority of instances allotments of suitable land are well cultivated, and rents are paid punctually. Unless a man has a family to provide for, however, an allotment in a rural district is often found unprofitable, if the ordinary rate of wages be charged for the time spent in working it. In such a district there is very little demand, as a rule, for vegetables, as nearly every householder grows them. But within a few miles of a large town there are always higglers who will buy the surplus produce of an allotment holder to sell again. Instances of allotment holders making handsome returns from a few perches of land are not uncommon. On the other hand, some holders declare that they could buy the produce of their land more cheaply than they can grow it. This statement involves a charge for the time spent in producing the crops, whereas one of the great advantages of an allotment is that its produce is obtained by labour in hours which would not otherwise yield any return, and which, moreover, would too often be passed in spending money in the public-house. Still, it is not every man who, after a day's work on a farm, is disposed to work for two or three hours on an allotment, so that there is no reason to be surprised at finding that the demand for allotments is frequently small where wages are comparatively high.

The great multiplication of allotments that has taken place since the Allotments Act of 1887 was passed has gone far towards spoiling the trade of the market gardener, who has lost the custom, not only of allotment holders, but also of housekeepers to whom the surplus of such holders is sold. Simultaneously the practice of growing culinary vegetables of certain kinds on large farms has increased, so that several causes have combined to reduce the usual prices of vegetables. While this tells against the making of much money profit off allotments, it is actually advantageous to the families of these small cultivators, who are well supplied with certain nutritious vegetables which they would not have if these had to be purchased. That is to say, the reduced temptation to sell increases the home consumption. From whatever point of view a supply of allotments equal to the demand for them is regarded, then, it is seen to be highly desirable.

In some parts of the country co-operative allotment associations have been formed, which are valuable in more ways than one. They help their members to obtain requisites at low rates, and in some cases to sell the produce of the land, while they also stimulate emulation in good cultivation, especially when they hold annual exhibitions at which prizes are offered; and they are further useful in the imposition of regulations which prevent causes of dispute among the allotment holders, or settle disputes by arbitration when they occur.

Allotments were very numerous in many parts of England long before the Allotments Act of 1887 was passed. That measure, indeed, had comparatively little direct effect; but it stimulated private action in the providing of land for allotments to a considerable extent. In 1890, however, it was deemed desirable to pass an amending Act, providing for action by County Councils in cases of appeals against the inaction of sanitary authorities, up to that time the administrators of the Act, aided by parish allotment managers. The Local Government Act of 1894, which created District and Parish Councils, transferred the powers of the sanitary authorities to the District Councils, and empowered Parish Councils to hire land for allotments by voluntary agreement, or, if necessary, to purchase or hire it compulsorily through the agency of the County Councils. The Small Holdings and Allotments Act of 1907 transferred the powers of the District Councils as to allotments to the Parish Councils.

It was not until 1892 that the Allotments Act for Scotland, similar to the English Act of 1887, except as to the administrative authorities, was passed. The local authorities for its administration were the Town Councils or Police Commissioners of burghs, and the County Councils in the rural districts, aided by allotment managers. The Local Government (Scotland) Act of 1894 transferred the powers of allotment managers to Parish Councils, and conferred upon the latter the same powers of acquiring land for allotments as were given by the corresponding measure for England. Like the English Act, too, it extended the limit of area which could be let as an allotment or allotments to one person from 1 ac. to 4 ac. No measure corresponding to the English Small Holdings and Allotments Act of 1907 has been passed for Scotland.

[W. E. B.]

Alloy.—Metals in the pure state, *e.g.* iron, lead, tin, aluminium, &c., although differing widely among themselves in physical properties, do not afford anything like the complete range of qualities demanded for application to modern industrial processes. This end is obtained by fusing these metals together in varying combinations and proportions, the result being an alloy of the metals employed. Every alloy may, in fact, be regarded as a new metal, since it generally possesses properties entirely different from those of the metals of which it is composed. Some metals mix in all proportions, some only in certain definite proportions, and some refuse to combine in a homogeneous whole, but remain as a conglomerate mass of visibly distinct metals. Brass, pewter, tin metal, solder, type metal are examples of alloys. The following table shows the different proportions in which the three common metals, copper, zinc, and tin, have been united as alloys for different purposes:—

	Cu.	Zn.	Sn.
Metal for frictional parts of locomotives (very hard)	87	5	8
Pistons of locomotives	88	9	3
Cross heads of connecting rods	82	2	16
Cylinders of pumps	88	2	10

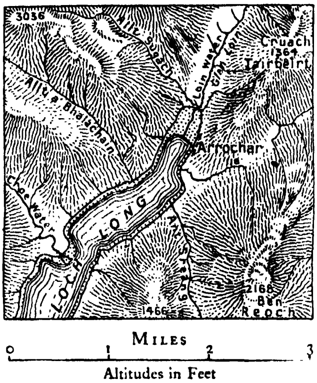
Allspice.—Allspice or Pimenta is the dried and ground berries of the Allspice tree. The taste is supposed to combine in itself the mixed flavours of clove, nutmeg, and cinnamon, hence the name Allspice. The trees which bear these aromatic berries are handsome evergreens, often 30 feet high, natives of the West Indies and South America. Botanically they belong to the Myrtle family, Myrtaceæ, and the technical name is *Eugenia Pimenta*, De Cand. In Jamaica, on the hills, the tree is cultivated extensively for the sake of its aromatic fruits, and hence the spice is sometimes called Jamaica pepper. A single tree has been known to yield 150 lb. of raw berries, which is equivalent to 100 lb. of the dried spice. The Allspice has been introduced into Southern India with complete success.

[A. N. M'A.]

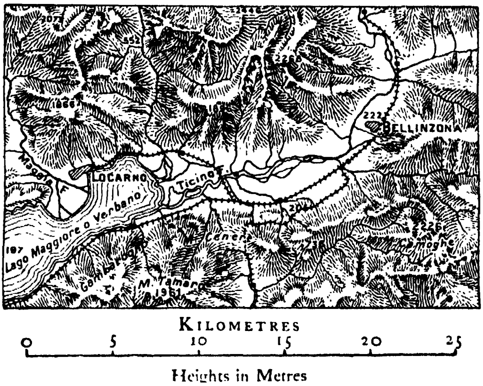
Alluvium and Alluvial Soils.—The term *alluvium* covers all material laid down along the course of a river, through the dropping of solid particles previously carried forward by the stream. Wherever the form of the ground promotes a sufficient slackening of the flow an alluvial deposit will occur, and this is likely to stretch out seaward or lakeward, and at the same time to spread backward up the valley, as the waters become more and more checked by the obstruction. The seaward or lakeward portion of the deposit forms the *delta*; the landward portion, between the valley walls, forms the *alluvial flat*.

The level surface of alluvium is often in marked contrast with the steep bounding walls on either hand, which represent the sides of a former ravine now choked and filled. In the present flat itself the river is seen to have a sinuous and shifting course. In its bends the stream cuts away the loose material on its concave bank, and a pebbly or sandy deposit is left on the opposite or convex bank. When some trifling obstacle has once started a curve in the stream course, this curve tends to become more and more emphasized. Hence, as the river moves from end to end of the alluvial flat, it swings this way and that in curves of increasing magnitude, until a very brief canal may suffice to connect two adjacent portions of the stream, and so cut off a mile or two of channel. Sometimes the stream thus shortens its own course for a while, and the deserted loop is left behind, to dry up finally, after passing through the phase of an elongated salt marsh. Such abandoned loops may often be seen on looking down from the hillside into the alluvial flat, and are common on a bold scale in the flood-plains of the Tisza and the Sava in Hungary and Croatia. The deposit of alluvium, though now and then assisted by general flooding, is thus being added to in various portions of the flat, and the wandering of the stream spreads it out with a very fair degree of uniformity. The lands along the valley walls require to be protected from the movements of the river, and the peasantry in mountain areas often unite to 'correct' the flow of the water, and thus reclaim a part of the alluvium. At other places, where floods are frequent, such a task is impossible, and the alluvium is used as a rough pasture ground for cattle, which feed amid the wastes of shifting stones.

Elevation of the land has in many places given new activity to a stream, which now cuts deeply into its alluvium, and exposes handsome sections of gravel, clay, and sand, illustrating the history of the deposit. Where, by local changes of level, or of climate, or in the nature of the material supplied to the upper reaches of the stream, alluvial deposition is at one time promoted, at another time altogether checked, a stream will cut into its flat, then choke up this channel, and then perhaps begin to cut a new groove in the latest alluvium. A series of *river terraces* may thus arise, the highest of which, appearing as a bench of gravel running along the hillside, will be the oldest. Of course, the complete rechoking of the valley, up to or beyond the level of its first alluvium, may obliterate certain phases of its history.



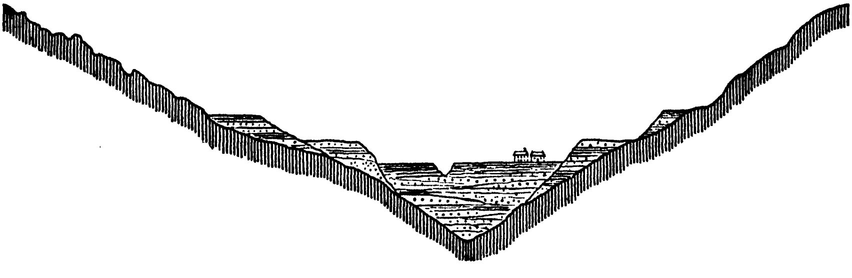
Map showing Alluvium and small Side Delta at the head of Loch Long, Scotland. (Reproduced from the Ordnance Survey Map, by permission.)



Map showing Alluvium of the Ticino, and Side Delta of the Maggia, for comparison with adjoining fig. (From the Swiss Government Survey.)

Alluvial flats are not confined to the lower courses of streams, since differences of hardness in the rocks and consequent differences of slope in the valley floor may promote here a gorge, here a deposit where the stream moves slowly. Lakes may even be silted up and represented by alluvium. Few things are more attractive as one descends a long valley than this contrast of green alluvial flats, seized on by the farmer, and the grim gorges between them, where the stream is still engaged in excavation.

The simplest type of alluvial deposit is seen in the cone of detritus thrown out where a side torrent enters on a main valley floor. An alluvial flat is in reality a long alluvial cone. A delta is formed by the thin extending edge of such a cone, or of a series of such cones.



Section across valley partially choked with Alluvium, in which the river is again excavating a ravine. Traces of two previous infillings of Alluvium, in the form of River Terraces, are seen higher up on the valley walls.

The materials of the alluvial deposit are thus immensely varied. The fine mud laid down when a flood subsides to-day may have as a subsoil a layer of sand, formed at a time when the waters could carry heavier material. But, on the whole, a sifting of the alluvium occurs, whereby the coarser types remain up stream, and the finer types become spread out seaward or lakeward. Gravels thus tend to gather near the highlands, while sands and mud flats mark the tidal reaches. Similarly where the stream is actually flowing, gravels accumulate along the banks, while the alluvial soil farther away from the stream, deposited in part from flooding, may be characterized by loams and clays. The fact that salt water (see art. FLOCCULATION) promotes a coagulation of the fine material into coarser composite grains prevents the alluvium from spreading very far from land.

The *alluvial soils*, from the fact that their materials may be derived first-hand from the rocks of some adjacent highland, have at times a certain freshness, and in such cases the constituent mineral particles are not sufficiently altered for their chemical constitution to have much bearing on the fertility of the soil. But in the majority of districts they represent the down-washing of soils that have already formed on higher levels, and the admixture of material from different sources is in itself of service to the farmer. The texture of the soil, as shown by mechanical analysis, may of course vary greatly in different portions of the valley, and in different terraces of the same hillside; but in any one sample of the alluvial soil there is found to be a marked uniformity of grain. Alluvial soils are, indeed, almost unique in this respect, owing to the natural separating action of the waters, which are the essential agents in their accumulation. They comprise, therefore, soils of such variable character as gravels, sands, loams, and clays. The gravels and sands constitute rather poor soils, capable generally, on account of the varied materials of which they are composed, of giving good crops of suitable kinds in seasons of abundant rainfall, but liable to suffer severely from drought. The alluvial loams and clays, on the other hand, if of sufficient depth, form the very best and most fertile soils of Britain. Sometimes, and especially along the higher stretches of rivers, they are too shallow, and the crops on them are liable to fail in dry seasons. But where their depth is sufficient they form the richest and finest soils, especially where, in the delta region, they have been formed by a combined deposit from river and from tidal waters, and have been enriched by the abundance of organic material—foraminiferal shells, &c., in the latter. Many tracts of alluvial soils are low-lying and difficult to drain, but the excess of moisture which makes them unsuitable for arable cultivation renders them exceedingly productive of grass, and they therefore yield some of our most valuable pastures. Where they can be efficiently drained they form the very best arable soils, and alluvial loams are adapted for the cultivation of all crops and reach the highest level of productiveness. The rents of alluviums are on the average higher than those of any other class of soils, and frequently have run from £3 to £5 per acre, while the yields of the leading crops may be as much as from 50 to 80 per cent higher than that of the whole country. Alluvial soils are of wide occurrence, being found in patches or tracts along the banks and at the mouth of every river, and all round the lower parts of our coast line, especially where sea and river have met. The largest deposits in our islands have occurred on the east coast, where are to be found the great area of 1700 sq. miles on the Wash and at the mouth of the Humber; the famous soils of the Carse of Gowrie, on the banks of the Tay, formed by the washings from Devonian and Highland rocks; and the hardly less valuable clays of the Carses of Stirling and the Forth. Throughout the northern English counties, especially York and Lincoln, are great tracts of valuable alluviums lying along the banks of the Derwent, the Ouse, and the Trent, and covering also great parts of the vale of York. Further extensive areas lie along the banks of the Thames, and constitute the Romney Marsh of Kent, famed for its large white sheep breed. On the west coast the most extensive alluviums are to be found on the banks of the Severn, round Bristol and Gloucester, and in Somerset, where alluvial soils form the finest grazing lands of England. On the Ribble in Lancashire, and south of Lough Neagh in Ireland, are also large tracts of productive and valuable alluvial soils. See also arts. on ROTATIONS, FARMING, SYSTEMS OF, WARPING, &c. [G. A. J. C.] [R. P. W.]

Almanac.—An almanac is essentially a yearly publication, which, in addition to a calendar of the days, weeks, and months of the year, usually provides information relative to the various astronomical phenomena, *e.g.* the rising and setting of the sun, the phases of the moon, eclipses of the sun and moon, the times of high water at particular ports, &c. The almanac may also convey information of a special character, according to the special class for which it is intended. Among almanacs of outstanding importance may be mentioned the Nautical Almanac, Oliver & Boyd's New Edinburgh Almanac, Thom's Irish Almanac, Whitaker's Almanac, Financial Reform, Church and University, Hazell's Annual. The Nautical Almanac is designed especially to supply information relative to the positions of the principal heavenly bodies at short intervals of time, from which data navigators are enabled to determine their geographical position. Oliver & Boyd's, Thom's, and Whitaker's supply information of a general statistical character.

Numerous agricultural almanacs and annuals are now published in this country, all supplying, in a greater or less degree, information of considerable value to farmers and others connected with the agricultural industry. The following list, though not complete, indicates the main sources from which these are obtainable:—

Agricultural Annual and Mark Lane Express Almanac (Dec., 1*s.*; W. A. May, 3 Wellington Street, Strand, London, W.C.). Agricultural Chronicle Diary (Dec., 3*s.* 6*d.*; F. W. Bridges, 119 Finsbury Pavement, London, E.C.). Annual Report of the Irish Agricultural Organization Society (June, 1*s.* 3*d.*; the Society, 22 Lincoln Place, Dublin). Farm and Home Year-Book (Dec., 1*s.*; W. Robinson, 17 Furnival Street, London, E.C.). Farmer and Stock-breeder Year-Book (Dec., 1*s.*; Macdonald & Martin, 6 Essex Street, Strand, London, W.C.). Journal of the British Dairy Farmers' Association (Dec., 1*s.*; 12 Hanover Square, London, W.). Journal of the Royal Agricultural Society of England (Jan., 10*s.*; J. Murray, 50a Albemarle Street, London, W.). Live Stock Journal Almanac (Dec., 1*s.* and 2*s.*; Vinton & Co., Ltd., 8 Bream's Buildings, London, E.C.). North British Agriculturist Calendar (Dec., 6*d.*; C. & R. Anderson, 377 High Street, Edinburgh). Peat's Farmers' Diary (Jan., 1*s.* 3*d.* and 5*s.*; Simpkin & Co., Ltd., Stationers' Hall Court, London, E.C.). Purdon's Irish Farmers' and Gardeners' Almanac (Jan., 1*s.*; Official Guide, Ltd., 23 Bachelor's Walk, Dublin). Scottish Farmer Album and Farming World Year-Book (Dec., 6*d.* and 1*s.*; The Scottish Agricultural Publishing Co., Ltd., 93 Hope Street, Glasgow). Transactions of the English Arboricultural Society (Dec., 2*s.* 6*d.*; J. Davidson, Haydon-Bridge-on-Tyne). Transactions of the Highland and Agricultural Society of Scotland (irregular, 5*s.*; W. Blackwood & Sons, 45 George Street, Edinburgh). Vinton's Agricultural Almanac (Dec., 6*d.* and 1*s.* 6*d.*; Vinton & Co., Ltd., 8 Bream's Buildings, London, E.C.). [J. B.]

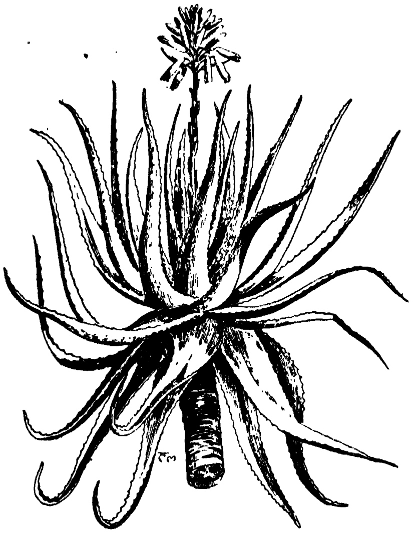
Almond (*Amygdalus*), a genus of trees of the drupaceous sub-ord. Amygdaleæ (nat. ord. Rosaceæ), which also comprises the other two genera of Peach (*Persica*) and Prune (*Prunus*, including Plums, Apricots, and Cherries). It differs from both of these, however, through its drupe having a tough, leathery, grey-green pericarp, which shrivels and finally opens on the fruit ripening completely, and also in the long oval kernel alone being edible; whereas these other two genera, the Peach and the Prune, have each a thick, fleshy, edible and juicy pericarp, while the kernel is of little or no use for edible purposes. Probably originally indigenous to the lower hills and the valleys of central and western Asia, the Almond tree has from time immemorial been cultivated throughout the warmer regions of southern Europe, and is now found there growing freely in a wild condition, and attaining a height up to 20 or 30 ft.; while even in the colder climate of Britain and central Europe it is largely grown for the ornamental effect of its beautiful whitish-pink to pale rose-coloured flowers, which bloom freely in March and April before the flush of the foliage. But it seldom produces edible fruit even in the warmer portions of southern England. Two varieties of the Almond genus are recognized, the Sweet (*A. dulcis*) and the Bitter (*A. amara*), but they offer no permanent botanical distinctions and often occur intermixed throughout any specific locality of growth. Most probably the sweet variety is the result of accidental variation perpetuated and improved by cultivation, while the bitter is a more or less partial throwing-back to the original wild condition. Most of the Sweet Almonds imported into Britain come from southern Europe, the Levant, and California, the finest being the so-called 'Jordan Almonds' of Malaga, and the Broad Almonds of Valencia; while most of the Bitter Almonds come from western Morocco. Both varieties may vary greatly as to their shells, some being thin and brittle, and others thick and sometimes intensely hard, but the common Sweet Almond in general cultivation has a thick, hard shell. Although only the sweet kind is used for dessert, both are employed for expressing from the seeds a fatty or greasy fixed oil, to the extent of about 50 lb. per cwt. (or over 40 per cent). Consisting almost entirely of trioleïn, a compound of glycerine with oleic acid, this oil is at first odourless and of a turbid, milky appearance, and has a mild, nutty flavour; but this becomes clear, light, and yellow as the impurities settle at the bottom, and soon turns rancid by exposure to the air. When obtained from Sweet Almonds this fixed oil has an agreeable taste and is very nutritious, and is used in confectionery, and medicinally as an emulsion to allay cough; that obtained from Bitter Almonds is largely used by perfumers. After this fixed oil has been expressed from Bitter Almonds, the cake left is further treated for the extraction of an essential 'oil of bitter almonds', obtainable from the *A. amara* only, and largely used in medicine, cookery, and confectionery. This essential oil is not found in a simple form in the crushed cake, which contains (along with other matters) amygdalin and emulsin or synaptase. When water is added to the bruised cake, the emulsin composing the vegetable albumen acts as a ferment on the amygdalin, and within twenty-four hours entirely decomposes it into volatile oil of bitter almonds, prussic acid, grape sugar, formic acid, and water. [J. N.]

Almond, Fungoid Diseases of.—Most of the fungi recorded as parasites on the Almond occur also on Peach, Apricot, or Cherry, which may be referred to.

Alnus. See ALDER.

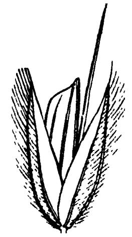
Aloe (*Aloë*), a genus of plants of the sub-ord. Aloineæ, nat. ord. Liliaceæ. It comprises about 200 species, over four-fifths of which are indigenous to South Africa and Socotra, although those of commercial value are now cultivated in all tropical and sub-tropical countries. The Aloes have stems varying up to about 30 ft. high, and bear thick, spiny, succulent leaves, whose sun-dried inspissated juice forms the valuable medicinal drug known as 'bitter aloes'. The leaves of several species, and especially of the *A. vera* of Barbados, also yield a good fibre, used for cordage and weaving by the negroes of Jamaica and Western Africa; but this product is different from, and of much less commercial importance than, the 'American Aloe fibre' produced by the Agave (see AGAVE). The value of the bitter drug depends not only upon the nature of the soil and climate, and the specific peculiarity of the plant cultivated, but also upon the care bestowed on its cultivation and preparation, and also upon the age of the leaves, and the season and the time of cutting. The medicinal value of bitter aloes was known to the Greeks in the 4th century B.C., and the Greek occupation of Socotra is said by the Arabian historian Edrisi to have been due to Aristotle's persuading Alexander to thus secure the monopoly of pure supplies of the drug. Till the 10th century Socotra remained the only source of supply to Europe, but about then aloe cultivation seems to have spread to other portions of the tropics, and now the drug is largely produced in many other parts of the world. It was probably known in Britain during the 10th century, as it is said to have been recommended to Alfred the Great by the Patriarch of Jerusalem, though it was not until the 17th century that a direct trade in it was opened between Socotra and Britain.

The four chief varieties sold in Britain are known commercially as: (1) Socotrine Aloes, the kind originally introduced, yielded chiefly by *A. Perryi*; (2) Barbados Aloes, chiefly from *A. vera*, first imported in 1693; (3) Cape Aloes (1780); and (4) Natal Aloes (1870), from *A. socotrina* and several other species. Though varying in degree as to their specific medicinal effect, all varieties have much the same sickly odour, due to a volatile oil, and also a bitter, unpleasant taste; and all are stomachic and tonic in small quantities, but purgative and cathartic in larger doses, whether used as pills, tinctures, or extracts. Barbados Aloes are more powerful than Socotrine, and more apt to produce griping pains. The active principles are due to complex crystalline phenols, known as aloins and forming a homologous series of compounds derived from anthracene ($C_{14}H_{10}$). Of these there are three varieties, distinguishable by chemical tests:—(1) Socaloïn or Zanaloïn ($C_{15}H_{16}O_7$), in Socotrine and Zanzibar Aloes; (2) Nataloïn ($C_{16}H_{18}O_7$), in Natal Aloes; and (3) Barbaloïn ($C_{17}H_{20}O_7$), in Barbados Aloes. The plants are easily cultivated on dry poor soil. In Barbados, where cultivation is systematic, the plants are set 6 in. apart in rows 1 to 1½ ft. wide, kept carefully weeded and manured. They are kept dwarfed, and the leaves (1 to 2 ft. long) are cut annually in March and April, during the heat of the day, and placed, cut end downwards, in V-shaped troughs to let the bitter juice exude from the vessels just below the epidermis. Colourless at first, it soon oxidizes to a brownish colour. This natural outflow gives the best quality, and sun-drying is preferable to artificial inspissation. [J. N.]



Aloe (*Aloe socotrina*)

Alopecurus.—This genus of grasses belongs to the division of the order in which the spikelets are one-flowered and the ear is a cylindrical spike (or more accurately a cylindrical spike-like panicle). Its peculiar character among such plants is to have a pair of very sharp-pointed glumes compressed sideways, and a single pale bearing an awn or beard at the back. The upper pale present in other grasses is absent in this case. *A. pratensis* (Meadow Foxtail), a fibrous-rooted, broad-leaved perennial, producing straw from 2 to 3 ft. long. The ear is about 2 in. long, blunt-pointed, cylindrical, and covered with silky hairs. The glumes are of equal length; the pale is of the same length as the glumes and much shorter than the projecting awn. Foxtail is found naturally in rich, moist pastures, where it forms an important part of the herbage, growing early and producing a considerable aftermath. It does not thrive in dry soils, and yet it is one of those grasses which bear most readily a high summer heat without burning, on which account it is much valued in France. The shoots of Meadow Foxtail are easily recognized—the underground base of the shoot is violet-coloured, and the leaf blades are broad, with flat ribs.



Spikelet of *Alopecurus pratensis*

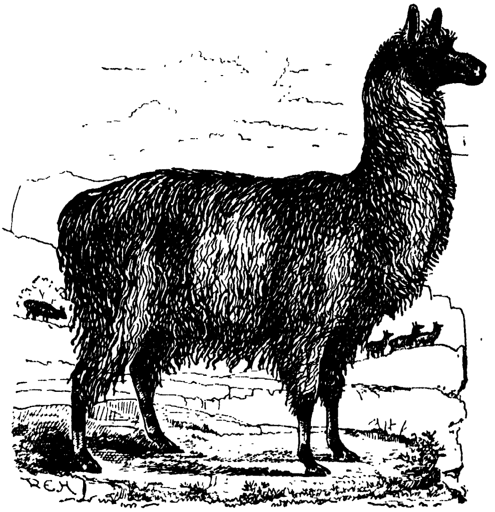
Meadow Foxtail is a permanent pasture-grass with large and broad leaf-blades, and in mixtures on heavy land one of the most valuable, not only on account of the earliness and the abundance of its leafy produce, but from its rapid reproduction of herbage when continuously eaten or cut down, and from the avidity with which it is sought after by all kinds of browsing stock. Since it requires three or four years after sowing before it attains to its fullest productive powers, it is unsuitable for alternate husbandry. As a hay grass it is usually considered of secondary importance, from its yielding comparatively few culms or stems, which are overripe for cutting before the other grasses in the mixture are ready. Foxtail enters largely into the composition of all the richest old pastures in Britain; it occurs most abundantly at low altitudes on deep rich soils of medium or strongish texture, when neither subjected to oversaturation nor excessive drought. Under careful cultivation it accommodates itself to a somewhat wider range of circumstances, thriving under judicious irrigation, and bearing, as has been said, high summer heats without burning, a property which renders this grass deserving of the attention of the Australian colonists. If sown alone, which is seldom or never expedient, 12 to 15 lb. of germinating seed would be requisite for an acre, but in mixtures 3 to 4 lb. is generally sufficient to yield a proper proportion of young plants. *Alopecurus pratensis* may often be seen in bloom towards the end of

April, but it usually flowers in May, or early in June, and ripens its seeds in June and the first week of July.

Alopecurus agrestis (Field Foxtail, Black Foxtail, Black Grass) is an annual weed of no value, but very common in meadows and on the sides of fields in the south of England, though rarely found in Scotland, unless where introduced among the seeds of Italian Rye Grass, or where its seed has been substituted for that of Meadow Foxtail. Field Foxtail is readily known by its straw being rough to the touch near the ear, by its having a slender taper-pointed ear, by the glumes having scarcely any silky hairs, and more especially by the extra length of the awn. [J. L.]
[A. N. M'A.]

Alpaca, Alpaco or **Paco,** one of the two races of the Llama domesticated from time immemorial by the ancient inhabitants of Peru and Bolivia. The Llamas (*Lama*), which, with the camels of the old world, constitute a peculiar group of ruminant ungulates, are confined to the mountainous western parts of South America and to the colder regions of the southern portion of that continent. They are represented at the present time by four well-marked types, two of which are exemplified by domesticated breeds, and two by easily definable wild species, the Guanaco or Huanaco (*Lama huanachus*) and the Vicuña (*Lama vicugna*). The Guanaco, which ranges from Peru and Bolivia to Tierra del Fuego, stands about 40 in. at the shoulder, and is of yellowish-brown colour, turning to white below and on the inside of the limbs. The head, face, and ears, however, which are covered with short and close hair, are smoky grey. The Vicuña, which does not appear to extend south of Bolivia, is a much smaller animal, standing only about 30 in. high. Apart from this difference in size, the Vicuña may be distinguished at once from the Guanaco by having the head and face shorter and more sheep-like and yellow-brown, like the body, in colour. Both are lightly yet strongly built animals, with the back arched and the legs long. The domestic races, on the contrary, known as the Llama (*Lama glama*), strictly so-called, and the Alpaca (*Lama pacos*), appear as a rule to stand lower on the legs and to have the body longer and the back flatter. Like all domestic animals, they vary in colour, the Llama being black, brown, white, piebald or skewbald, and the Alpaca usually black or white, black being the prevalent type. The Alpaca is a smaller animal than the Llama, and has the neck relatively longer, with the ears shorter, more rounded, and not so markedly incurved at the tip.

The origin of these domestic breeds is not as yet definitely settled. Some have considered them to represent two species distinct from each other and from the two wild forms. Others have held that the Guanaco is the wild prototype of the Llama, and the Vicuña that of the Alpaca. Most modern naturalists, however, incline to the belief that the Guanaco must be looked upon as the parent stock of both the domestic breeds, a belief based upon Mr. O. Thomas's statement that the cranial characters of the latter agree more closely with those of the Guanaco than with those of the Vicuña. It is certainly the case that some Llamas, alike in coloration, size, and in the shape of the skull, closely resemble the Guanaco, and it must be regarded as probable that the Llama is a domesticated and modified form of that species. The Alpaca, on the contrary, in the size, shape, and structure of its skull, shows so many points of resemblance to the Vicuña that it is almost impossible to doubt the presence of at all events a strong strain of Vicuña blood in the Alpaca. It is known that Llamas and Alpacas are mutually fertile when crossed, and this is most likely the explanation of the existence of intermediate forms between the two breeds.


Alpaca (*Lama pacos*)

Before the introduction of horses and mules into South America, the Llama was the only beast of burden used by the Peruvians. The Alpaca, however, was never apparently employed for this purpose, but was preserved and bred exclusively for its wool, from which blankets, cloths, and other articles were woven. The coat is extremely luxuriant, and often so long as almost to sweep the ground. Like sheep the Alpacas were annually sheared; but, unlike sheep, they do not naturally shed their wool. The wool is of two kinds, the under wool being comparatively short and soft, and the outer wool coarse and long. Cloth made from imported Alpaca wool is manufactured in England principally at Saltaire, near Bradford, in Yorkshire.

On account of the commercial value of the wool, attempts have from time to time been made to introduce and acclimatize the Alpaca in Europe and also in Australia. No measure of success, however, has attended the experiments, because of the inability of the survivors of the long voyage to adapt themselves to conditions so different from those prevailing at an altitude of about 15,000 ft. in the Andes, where for long ages the Alpaca has lived both in winter and summer in a domesticated or semi-domesticated state. [R. I. P.]

Alpine Garden.—The term 'alpine plants' is used for many plants that are not from mountainous regions, and the alpine garden generally means the rockery, an arrangement of stones and soil for the cultivation of low-growing, hardy plants that, as a rule, will not thrive in the ordinary border. The first necessity is good drainage, and a situation where there is plenty of sunlight, free from the shade of trees. For the construction of the alpine garden, pieces of stone, the rougher and more weathered the better, and a good loamy soil must be provided. The simplest arrangement is that of the barrow-shaped rockery. An irregular line of stones being placed upon the ground, soil should then be filled in behind them, and then another irregular row set farther back, so as to leave pockets of soil at the base of most of the stones, soil being filled up at the back as before, and so on until the required height has been reached. The rise of the 'steps' thus formed will be decided by the width of ground to be covered. The important point is that below each pocket there shall be a full depth of good soil. To arrange the stones first and then fill in with soil is to court failure. The stones should rest quite firmly, and in placing them attention should be paid to the natural strata or grain of the particular stone used. Where there is a mound or sloping bank of soil, an alpine garden is easily made by letting in stones here and there, so as to provide pockets and give the effect of rocky ground. The sunk rockery is easily made, and is perhaps the best form where the ground is flat. It is on the principle of a railway cutting, with the stones arranged as above described on the sides. Groups of rhododendrons and other evergreens, including Coniferæ, may be placed here and there along the top of the slope, to provide shelter and a sort of frame to the arrangement. The selection of plants suitable for such a garden is best made with the assistance of a dealer, whose catalogue will be helpful. [W. W.]

Alsike.—A distinct species of the Trifolium or Clover genus of Leguminous plants. See CLOVERS.

Alternate Husbandry.—The system of agriculture which involves a regular and orderly succession of crops. See ROTATION.

Altimeter, Altimetry.—Any instrument designed for the measurement of the vertical distance between two points may be called an altimeter. For the measurement of the heights of trees, buildings, &c., the theodolite is in common use. Heights of mountains are frequently determined by means of the barometer. For the rough estimate of altitudes the following rule will suffice: As the sum of the heights of the mercury at the top and bottom of the mountain is to their difference, so is 52,000 to the height to be measured in feet. A pocket aneroid is very useful for this purpose.

Altitude, or height above mean sea-level at Liverpool, is indicated on the ordnance survey maps by contour lines, by bench marks (the broad arrow, with horizontal line above, cut on some permanent object), and by levels marked on highways. The new 1-in.-mile general maps for England and Wales, the maps of the original survey of Scotland, and the county maps for the United Kingdom on the 6-in.-mile scale have contour lines. The county 6-in.-mile maps show also the position and relative altitude of the bench marks. The parish maps on the 25·344-in.-mile scale have no contour lines, but show the elevation by the bench marks, and by levels indicated on the highways at frequent intervals.

Altitude is one of the main determining influences of local climate. Increase in height has the same effect on temperature as increase of distance north or south of the equator. Temperature is estimated to be lowered 1° F. for every 300 ft. of a vertical rise. This fall in temperature is due to two main causes. At a height the air is less dense, the barometric pressure falling 1 in. for every 1000 ft. of elevation. The intensity of solar radiation may be greater on mountains than in the valleys, but this heat is not communicated to the air, nor can the rarer air deficient in moisture be heated by the rays radiated back from the soil. The natural fall of pressure as height is increased causes rising currents to expand, and this expansion being work, uses up heat energy to bring it about, and the air becomes cooler. This diminution of temperature in ascending currents is greater when the winds are dry; moist air recovers some heat on cooling, through the liberation of latent heat in the condensation of the vapour carried by it. In all cases rain is produced by the cooling of air carrying more or less vapour below the point at which it can hold that amount of moisture. Generally speaking, rain is more abundant on the seacoasts than in inland regions, and among hills and mountains than in lowland flatter regions. The large rainfalls for which many places are noted are brought about by the interposition of elevated tracts of land in the path of moisture-carrying winds from the sea. Likewise, rainless districts are found where the prevailing winds have been deprived of their vapour in passing over high ground, and descend on the farther side not only dry but with an increasing capacity to evaporate water, owing to the rise of temperature and pressure at a lower level.

For an account of the influence of altitude on plant and animal life see article EXPOSURE. See also *Hill Farming*, under FARMING, SYSTEMS OF. [J. ST.]

Alumina.—Alumina is the oxide of the metal aluminium. It occurs pure in nature in a colourless crystalline form as corundum; when coloured by traces of other metals it occurs as the precious stones—ruby, sapphire, amethyst—and as emery. It is also found in an amorphous state. The oxide combines with water, forming a hydrate. The latter is a white, gelatinous substance, and can be prepared by the addition of ammonia to a salt of aluminium dissolved in water. It is readily soluble in acids and alkalis; in combination with sulphuric acid and an alkali it forms an important series of salts called alums.

Alumina is not a plant food, though it is found in the ash of a certain species of plants, namely, the club mosses. As a constituent of soils it is of great importance. In combination with silica and water as a double silicate of alumina, it forms the largest constituent of clay soils; united with water as aluminium hydrate, it is present in much smaller amounts. The retentive power of clay soils for potash, ammonia, and phosphoric acid is largely due to the presence of these two substances. The hydrated silicate of alumina absorbs potash and ammonia, whilst the alumina retains the phosphates as an insoluble aluminium phosphate.

Although alumina is not a plant food, it nevertheless has a very powerful indirect influence upon plant growth by largely determining the character of those soils of which it forms an essential part. Pure hydrated silicate of aluminium is kaolin (porcelain clay), and is derived from the decomposition of igneous rocks (granite, &c.), of which it forms an important constituent. Clay is a very impure form of this salt. For further information see Clay. [R. A. B.]

Amaurosis, or Glass Eye. — Actual blindness, in eyes perfectly transparent but lacking in the sense of perception of objects, has been long recognized in animals as 'glass eye', and it is a good description. The optic nerve and retina are paralysed—the eye insensitive to light, and the pupil always dilated. Unless caused by loss of blood, by lead poisoning, or debility, it is incurable. Nux vomica and its preparations have proved serviceable in some cases. It has been traced to blows and falls, producing concussion of the deep-seated origin of the nerves (optic thalami), but no characteristic lesions have been discovered after death. [H. L.]

Amble, Ambling, Pacing.—This is a mode of progression mostly acquired in the horse, but natural to certain other quadrupeds, notably the dog, the chamois, and the dromedary. It is of the nature of an irregular trot, characterized by the alternate play of the right and left limbs. The two limbs of the right side are raised and lowered simultaneously, and the two limbs of the left side alternate with them. The body of the animal is thus always out of equilibrium, and he contrives to support himself by a forced oscillation from side to side. Even thus he would fall away laterally but for the quickly recurring change of side and the closeness with which the hoofs keep the ground. Great rapidity of action is gained in the amble, for not only does the horse lift his hind leg simultaneously with his fore leg, but he sets it down fully a foot in advance of the fore one of the same side, and the farther in advance he gets it the easier is the amble. The smooth, gliding motion of the amble is very pleasant to the rider. There is no jolting such as is occasioned by the resistance offered by the fore leg to the raising of the hind leg in the trot. It is, however, very fatiguing to the horse. Horses which naturally amble seldom trot, and it will be often found that they suffer from some malformation or defect of constitution. Good horses which have been overworked and are on the decline, also seem to prefer the amble to any other rapid pace. Even young horses when fatigued may sometimes be seen to fall into this pace. A common practice in order to teach a horse to amble used to be to ride a young horse through ploughed fields till fatigue drove him to amble by way of relief. By so doing, the risk of shoulderslip or other strain was incurred. Methods in which weights are used are open to the same objection. It is preferable to teach the horse to amble by alternate forward pressure of the hands, and correction with the calves of the legs, first on one side, then on the other. [J. S.]

Amblyomma (Bont Ticks), a genus of Ticks. Not represented in Britain. One species is well known, namely, the Bont Tick (*Amblyomma hebræum*), in Africa, as it is the carrier of the fatal 'heartwater' disease of sheep, which renders much of the veldt of the infected districts useless for sheep-farming. [F. V. T.]

Amel Corn, the larger Spelt, an inferior variety of wheat (*Triticum vulgare dicoccum*), called also French Rice. See Spelt.

Amelioration, the process of increasing the agricultural value of soils by drainage, liming, tillage, the application of manures, &c. See Improvements.

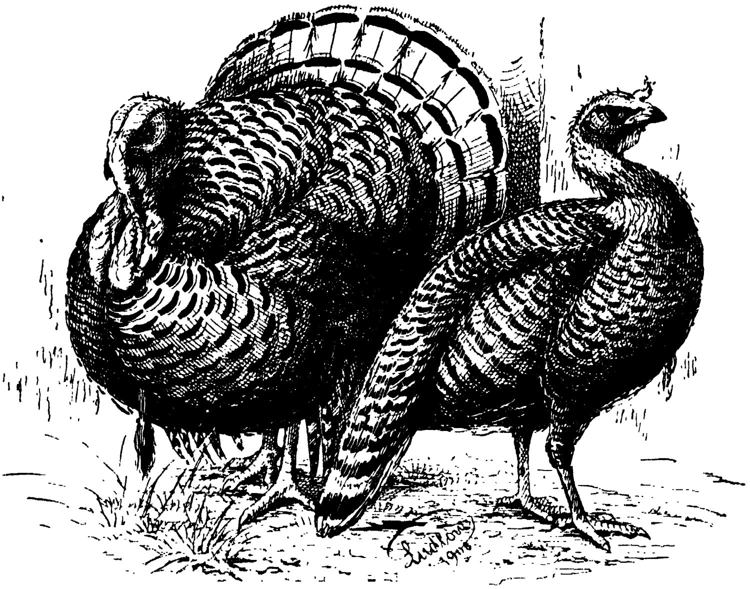
America, Agriculture of. See Argentina, Canada, United States, &c.

American Aloe. See Agave.

American Blight, a term applied to the ravages of the Woolly Aphis, one of the most widespread plantlice affecting fruit trees. See Schizoneura.

American Bronze Turkey. — North America is the home of the bird to which has been given the name of Turkey (See Turkey, Breeds of), and it is yet to be found in a wild state in some parts of that section of the western continent. How long since the race which we now know under the above designation was tamed it is impossible to say, but probably at least 200 years. The first specimens imported into Europe appear to have reached our shores in the early years of the 19th century; but at that period they did not attract much attention from farmers, for the reason that they were, if anything, too large in size of body, and also, they were only partially domesticated. Meanwhile, much had been done in America to bring the race into the service of man, and about forty years ago further importations took place. At that time, owing to the partial exhaustion of our native breeds, to the demand for bigger birds, and to the rise of the exhibition system, in which brilliancy of plumage is an important factor, the American Bronze Turkey was received with favour denied to it previously, and, as a consequence, it rapidly increased in popularity. Upon the farms of Great Britain it is now found to a larger extent than any other of the Turkey family, though it cannot be regarded as the finest in quality of flesh. A greater vigour of constitution and large body have, however, secured it the position it holds.

In conformation of body this race is long, deep, and broad, the breast is prominent and carried well forward, and the greatest depth is midway in the body, rising sharply both before and behind. It has a strong head, with long neck and legs. The wings are large and powerful, as must always be the case in order to obtain great muscular breast development. This is a point which should always be kept in mind, for one cannot be secured without the other. The plumage is brilliant, showing on the neck and breast a rich, dark bronze, the back and sides being of a similar colour, but each feather has a narrow band of black at the extremity, giving a rather more sombre appearance. The wings when spread show alternate bars of bronze and grey, and the wingbows are bright-black. The tail in the male has bands of light-brown and black alternately, and grey tips. The appearance of these birds in the sunlight is very fine, and the bronze reflections are then very brilliant indeed. As already mentioned, the American Bronze Turkey is large in size, and matured specimens have been seen weighing nearly 50 lb. These are not found to be satisfactory for breeding purposes, and it is generally thought that males of 24 to 26 lb. and females of 16 lb. give the strongest progeny. They are quick in growth, and young cocks at Christmas, when they are about nine months old, can be obtained to scale at 20 to 30 lb. if they are properly fed off. That being so, the popularity which the breed has attained is explainable, for birds of the size named command much better prices *pro rata* than smaller specimens at the Christmas and New Year seasons of the year, when the demand for these birds is very large.



American Bronze Turkeys

As is the case with all members of the Turkey family, the flesh is chiefly found on the breast as compared with the legs, in which respect the American Bronze has excellent qualities. The flesh and skin are white, with, however, an inclination to grey. Many of these birds are somewhat baggy in front, and although this gives them the appearance of size it is deceptive. The flesh, whilst abundant, lacks the softness of some other breeds, although in that respect there is much difference in accordance with the soil on which the birds are reared, and the way in which they are fed both during the earlier and final stages of development. The skeleton is large and the bone heavy, and members of this race can generally be distinguished when dead by the prominent sternum or keel, which is seldom fully covered with meat. [E. B.]

American Cranberry. See CRANBERRY.

American Cress. See CRESS.

American Trotter. See TROTTING HORSES.

American Waterweed. See ANACHARIS.

Amides.—Amides are important compounds of nitrogen found in plant and animal substance. They are derivatives of ammonia in which one atom of hydrogen in the ammonia has been replaced by an acid group. They are generally crystalline bodies, readily soluble in water, and giving a neutral reaction to litmus papers. They also form compounds with acids, and are readily saponifiable.

Their function in vegetable growth is not well understood, yet they appear to play an important part. Along with albuminoids they form the two principal compounds of nitrogen existing in plants. The relative proportion of each present is variable. Generally the amount of amide nitrogen is greater in plants during active growth. As the plant matures it slowly decreases, accompanied by a corresponding increase in the amount of albuminoid nitrogen. The following figures, taken from Warington's Chemistry of the Farm, show the proportion of albuminoid and amide nitrogen in hay made at different dates:—

Date of Cutting.	Nitrogenous substances in dry matter.	
	% Albuminoid.	% Amide.
May 14	11·5	6·2
June 9	9·4	1·8
„ 26	7·8	0·7

Nitrogen is taken up by plants principally in the form of nitrate, and it is possible that in the process of growth the nitrate is first converted into ammonia, then amide, and finally albuminoid nitrogen. The above figures seem to bear out this point. Similar changes in the nitrogen content of most succulent crops are found. Seeds rarely contain more than a very small proportion of the combined nitrogen as amide, likewise the total nitrogen in ripe straw is poor in amide and rich in albuminoid nitrogen. About one-half of the total nitrogen in root crops consists of amide nitrogen.

Besides their existence in plants, apparently as an intermediate stage in the formation of albuminoids from the nitrates taken up by the root, they are found in germinating seeds as one of the products in the breaking down of proteids by proteolytic enzymes, previous to their acting as nitrogenous foodstuffs for the growing plumule. Thus malt is rich in amide nitrogen. In the preparation of silage, much of the albuminoid nitrogen is converted into the amide form. In the digestion processes that food undergoes in the alimentary canal, the albuminoids appear to be split up into amido compounds before their assimilation into the blood. As the amide urea and allied compounds they abound in the urine, and hence appear to be a form in which the body excretes its waste nitrogenous compounds.

Some of the commoner amides found in plant and animal tissues are—asparagin, betain, leucin, glutamin, tyrosin, glycocol, urea, &c. In order to convert the percentage of nitrogen into amide nitrogen, the factor 6·25 is generally adopted. For the amide asparagin the factor 4·7 is more correct. The product obtained by multiplying the percentage of nitrogen in amides with the proper factor gives the percentage of amide.

The value of amide nitrogen as a foodstuff is very small. It appears to play an insignificant part, unless under exceptional circumstances, in the building up of the nitrogenous tissues in the animal body. It is therefore important to know the relative proportion of nitrogen as amide and albuminoid in vegetable material intended for feeding purposes. See arts. on Feeding and Foods. [R. A. B.]

Ammonia is the name given to an important compound composed of 3 parts of hydrogen united with 1 of nitrogen. It does not occur in the free state in nature, but always in combination with acids or other chemical substances. It can be readily prepared by the action of an alkali upon a salt of ammonia; thus if quicklime be added to sulphate of ammonium, a colourless gas is at once given off, perceived by a powerful and characteristic odour. It is caustic to the taste, and strongly affects the eyes. It is lighter than air, and extinguishes a burning taper. The gas is exceedingly soluble in water, and forms a solution sold in commerce under the name of liquor ammonia. This solution turns the red vegetable colouring matter litmus blue. It is a very stable compound and not easily broken up into its constituent elements.

Ammonia is a very powerful alkali, and combines with acids, forming salts (see Ammonium Salts). This is its most important property. Its salts are of immense value to agriculture, for they provide one of the few combined states in which nitrogen can be used as a plant food. See Manures.

In small quantities it is continually being produced in nature from the decay of vegetable and animal substances. It was found by old chemists that when horn, hoof, and other animal substances were heated, a peculiar smelling gas was given off, to which when dissolved in water they gave the name spirits of hartshorn. Ammonia is still called occasionally by that name, or simply hartshorn. The decaying remains of plants in soils slowly give up their nitrogen as ammonia through the action of certain bacteria. This progressive formation of ammonia in soils is of great importance to growing plants. The well-known odour of farmyard manure is very largely due to the evolution of ammonia during the rotting of the dung.

The principal supplies of ammonia come from gas works, blast furnaces, and shale works. Coal contains about 1 per cent of nitrogen, and when heated for the purpose of making illuminating gas, the nitrogen is given off as ammonia along with the other gases, from which it is separated by bubbling the mixed gases through water. The ammonia dissolves, and from the gas liquor obtained pure ammonia is prepared.

The origin of ammonium salts in the atmosphere will, from the foregoing remarks, be readily understood, yet it is only found there in minute quantities (see Atmosphere). Being a gas, it will be seen that great losses in nitrogen might ensue when ammonia is produced during the fermentation of nitrogenous substances. Some soils have the power of absorbing ammonia, and the same property is likewise possessed by some chemical substances, such as calcium sulphate and all acid salts, the latter combining with it, forming stable compounds. The best absorbent, however, is carbon or charcoal, which takes up many times its own volume.

Ammonia enters into combination with many organic bodies. The more common of those occurring in plants and animals belong to a class of compounds called amides. See AMIDES.

[R. A. B.]

Ammonium Salts are of extreme importance to agriculture as nitrogenous manures (see MANURES). They are formed when ammonia and an acid are brought together. In small quantities they are found widely distributed in nature — minute amounts exist in the atmosphere, rain and most other natural waters, in the juices of plants, and solid excrements of many animals; larger amounts are found in the liquid excreta, also in soils and soil waters. Nitrogen is found stored up in soils, in combination with carbon, hydrogen, oxygen, sulphur, and phosphorus. These compounds exist in the dead remains of roots, stems, and leaves of plants, and on decomposition their nitrogen is evolved as ammonia.

Though the occurrence of ammonium salts in nature is generally in minute quantities, the amounts available from such sources are, however, of the highest importance to agriculture. Guano, rich in nitrogen, found in deposits on the west coast of South America, formed at one time a valuable source of these salts. This supply was, however, soon exhausted.

Ammonium salts at the present time are chiefly obtained from:—

1. The destructive distillation of bones, horn, leather, and other animal substances.
2. By-product from coal in the manufacture of illuminating gas.
3. Beetroot-sugar factories.
4. Furnace gases of ironworks and shale works.

Some of the principal salts are the sulphate, chloride, carbonate, and nitrate of ammonia. They are all crystalline, and readily soluble in water. When brought in contact with an alkali they are decomposed with evolution of ammonia. They are stable at the ordinary temperature, but on heating split up into their component parts. Some of the constituents of soils have the power of replacing ammonia from its combination with acids, liberating the ammonia which is retained by other compounds in such a form that it is not readily removed from soils by the drainage water. The above-mentioned salts are all prepared by the action of ammonia upon their respective acids.

The sulphate is got principally from the ammonia in gas liquor. Thus prepared it may contain the impurity ammonium thiocyanate, which, even in minute quantities, is injurious to plant growth. See SULPHATE OF AMMONIA.

The chloride, muriate, or sal ammoniac is purified by sublimation of the ordinary crystalline salt. This latter salt, which is generally known in commerce as sal ammoniac, is, however, pure enough for most purposes.

The carbonate, sal volatile, is generally a mixture of ammonium carbonate and carbamate. It can be prepared by heating together sulphate of ammonia and calcium carbonate in large iron cylinders; the vapours coming off are led into cooling chambers, where they unite, and the impure salt is deposited as a crust on the walls of the vessel. It is then purified by resublimation, and the carbonate finally obtained is deposited as a white fibrous crust. In this form it is sold in commerce. It is readily volatile at the ordinary temperature, and it is in this state that ammonia is found to exist in the atmosphere, and to be given off from decomposing urine.

Ammonia forms salts with organic acids, and in combination with benzene it forms the important compound aniline, the basis in the preparation of many dyes. [R. A. B.]

Ammophila, a name for a grass, commonly called Maram or Sea Mat Grass, frequent on British sea coasts. See PSAMMA.

Amœba meleagridis (Parasitic Liver Disease in Poultry), a minute protozoön which is parasitic in gallinaceous birds, the cause of so-called 'black-head' of turkeys in America. It also occurs in Britain. The protozoön invades the tissues of the cæca of the intestines of turkeys and fowls, and produces a swollen appearance. It has also been found in partridges in Kent. It reproduces in the tissues of the cæca by division, and through the blood reaches the liver, where it forms mottled grey and brown areas, which as the hepatic tissue dies turn to yellow cheesy spots up to ⅔ inch across. These spots are very similar to and often mistaken for tuberculosis. The effect on the liver is to cause it to swell often to twice its normal size. The amœbæ escape by the intestines in the excreta, and are ingested by other birds. It frequently occurs that the head becomes puffy and darkened, hence the name 'black-head'. All diseased birds should be isolated or killed, and runs disinfected with 10-per-cent carbolic, or 1-per-cent sulphuric acid.

[F. V. T.]

Ampelopsis.—A genus of useful hardy climbers closely akin botanically to the grape vine. The best of them is *A. Veitchii*, which grows rapidly, is selfsupporting, attaching itself by means of its sucker-like tendrils to walls or fences, which it soon covers, and in summer presents a drapery of rich glossy green leaves, changing to crimson and orange in autumn before they fall. Old plants produce lobed leaves, much larger than when the plants are young. The common Virginian Creeper, *A. quinquefolia*, is another useful plant for providing a screen or covering a summer house, arbour, &c., and its foliage also changes to a rich crimson colour in autumn. There are several new species of recent introduction from China, such as *A. Thomsoni*, *A. Wilsoni*, and *A. Henryi*.

[W. W.]

Amphibole.—A name introduced by Haüy in 1809 for hornblende, and since extended over a group of allied minerals. The amphiboles form a parallel series with the pyroxenes (see art. PYROXENE), both consisting fundamentally of molecules with the composition $RSiO_3$, in which R represents, in ordinary species, calcium, magnesium, and iron. Alumina and ferric oxide, however, occur in many of the species. It seems probable, from experimental researches, that every amphibole has a possible representative in the pyroxene group, identical with it in chemical composition. The analyses, however, of hornblende, the common amphibole, do not give precisely the same formulæ as those of augite, the common pyroxene. The essential difference between the amphiboles and the pyroxenes lies in the relations of the two sets of planes of weakness, or mineral cleavage, that traverse the crystals. In the amphiboles these intersect at about 56°, and in the pyroxenes at about 87°. The vertical axis of the crystal-forms is selected as parallel to these cleavages, and two pairs of external faces, each pair parallel to one of the cleavages, build up the typical prism. Hence the amphibole prism has angles of about 56° and 124°, while that of pyroxene is nearly rectangular. The species in each group have to be referred to various crystallographic systems, on account of differences in the symmetry of their crystals; but the prism-angles remain as above stated throughout each group.

Amphibole very commonly arises as an alteration product of pyroxene. This appears to be largely a matter of geological time, the pyroxene being unable to withstand the prolonged influence of certain conditions of pressure and temperature underground. Hornblende or actinolite is thus formed as patches in augite, or as a complete replacement of crystals of that mineral. Many rocks rich in hornblende, such as diorites, were undoubtedly at one time rich in augite.

The simplest amphibole, *anthophyllite*, has the composition $(Mg, Fe) SiO_3$, a metasilicate of magnesium and iron. *Tremolite*, and its very fibrous form *Asbestos*, have calcium in place of iron, and the composition $CaMg_3(SiO_3)_4$. *Actinolite* is a tremolite with iron replacing some of the magnesium. In *Hornblende* (see art. HORNBLENDE) the composition is further complicated by the occurrence of alumina and ferric oxide.

[G. A. J. C.]

Amputation.—Severance of living parts, as a limb, a tail, or an ear, may be undertaken to save life, or merely as a dictate of fashion. If antiseptic measures are taken, and hæmorrhage provided against, but little risk of death from shock is entertained. Seldom indeed is a horse or a cow worth keeping with an amputated limb, although examples of cows might be named. Sheep may have a crushed limb amputated, with some hope of recovery, as may young stock intended for the butcher at the earliest date.

Amputation of the tail, or 'docking', of certain breeds of horses is still demanded (see DOCKING), and in regard to lambs is well-nigh a necessity. The crude methods commonly adopted have the recommendation of being generally successful, but in hot climates, or in fly seasons in Britain, the application of Stockholm tar to the stump of lambs' docks is calculated to save them from being blown and breeding maggots. Amputation of supernumerary teats upon cows' udders is successfully practised, and should be performed when the cows are yeld; antiseptic measures being, of course, adopted. Amputation of the penis in cases of cancer, of the ear, and other parts is sometimes necessary.

[H. L.]

Amygdalus, the botanical name for the almond. See ALMOND.

Anacharis canadensis, or *Elodea canadensis* (American Waterweed, Canadian Weed, Waterweed, Water Pest).—This is an entirely submerged aquatic monocotyledonous plant of the Frog's-bit family (Hydrocharidaceæ), with whorls of leaves so transparent that they readily show, under the microscope, minute details of structure, and the rotation movements of the living protoplasm in the cells. This waterweed first appeared in Britain about the middle of the 19th century, and was probably introduced from America, where it is very common in slow streams and ponds. The plant attracted considerable attention, for it propagated so extensively in many of our canals as to interfere seriously with the traffic. The plants in our canals are all females and perfect no seed, so that the extensive spread is due entirely to extreme vegetative vigour, not to reproduction by seed. Male plants are very rare in this country. Anacharis is thus a diœcious plant, like Hop and Hemp. [A. N. M'A.]

Anæmia.—Deficiency of blood, particularly of the red corpuscles, may result from any wasting illness, or from insufficient food. There is a persistent or so-called pernicious anæmia among sheep and other species of animals, giving rise to much serious loss, especially to flock-masters, the cause of which has not been positively ascertained, but is thought to be due to an organism which attacks the red blood corpuscles. Anæmia arising from other causes, as loss of blood or debilitating illnesses, will commonly yield to treatment by iron and other tonics, combined with a liberal diet and good hygienic conditions· but the pernicious form is usually fatal.

[H. L.]

Anaërobes, bacteria which obtain their oxygen by breaking up oxygenated compounds. See BACTERIA.

Anagallis, a genus of the nat. ord. Primulaceæ, to which belongs the Pimpernel or Poor Man's Weather-glass—a common weed of cultivation. See PIMPERNEL.

Analysis.—The word 'analysis'—strictly, 'breaking up'—was introduced by Boyle in the latter part of the 17th century to denote the chemical process of discovering what things are present in a particular substance. Ever since then it has been recognized as one of the most important branches of the chemist's work, and all chemists who have turned their attention to agriculture have necessarily made large use of analysis.

Analysis may be regarded from two standpoints—as an aid to investigation, and as a means of testing soils, feedingstuffs, manures,

&c. Since the methods used for testing have frequently grown out of those used for research, it will be more convenient, as well as more logical, to begin with some account of the use of analysis in investigations.

It is perhaps not too much to say that most of the important discoveries in agricultural chemistry have been made by collecting and studying analytical data. For a time figures are being accumulated, but they are of little use till some master mind collects them, and deduces from them a broad generalization or a new law of science.

An admirable illustration of the necessity for pioneering analytical work is afforded by the history of the laws of manuring. Even during the 18th century many analyses of agricultural interest were made, but the earliest of importance are a series made by de Saussure, and published in his classical Recherches chimiques sur la Végétation (1804). He examined the ashes of a number of plants, including wheat, barley, oats, maize, peas, vetches, and several trees, and drew up what is perhaps the first table on record showing the amount of various constituents present. He invariably found phosphorus, which he thought was probably essential to the plant. The table was greatly extended by Bertier, Sprengel, and others, but it remained a collection of data of scientific rather than of practical interest.

A new scheme was started by Boussingault. This brilliant investigator started life as an adventurous traveller in South America, but on his return to France he began a series of experiments on his farm at Bechelbronn, which were continued for a number of years, and added largely to the knowledge of the time. He not only weighed the crop, but also analysed it, and was thus in a position to determine exactly how many pounds of each constituent were present in the crop growing on an acre of ground. He also weighed and analysed the manures put on, and so determined the weight of each constituent supplied. This was continued through a whole rotation, and a table was then drawn up, showing how far the added material sufficed for the needs of the crops, and how far the air, soil, and rain had been drawn on for supply. One given by him is as follows:—

	Weight in kilograms per hectare of					
	Dry matter	Carbon.	Hydrogen.	Oxygen.	Nitrogen	Mineral matter
1. Beets	3172	1357·6	184·0	1376·7	53·9	199·8
2. Wheat	3006	1431·6	164·4	1214·9	31·6	163·8
3. Clover hay	4029	1909·7	201·5	1523·0	84·6	310·2
4. Wheat	4208	2001·2	230·0	1700·7	43·8	229·3
Turnips (catch crop) ...	716	307·2	39·3	302·9	12·2	54·4
5. Oats	2347	1182·3	137·3	890·9	28·4	108·0
Total during rotation ...	17478	8192·6	956·5	7009·0	254·2	1065·5
Added in manure	10161	3637·6	426·8	2621·5	203·2	3271·9
Difference not accounted for, taken from air, rain, or soil.	+ 7317	+ 4555·0	+ 529·7	+ 4387·5	+ 51·0	– 2206·4

1000 kilograms per hectare = 16 cwt. per acre.

(From Annales de Chimie et de Physique, vol. i, p. 242; also Économie Rurale, vol. ii, p. 185.)

Since the productiveness of the soil was fully maintained it can have lost no great quantity of essential fertilizing elements; the carbon, hydrogen, and oxygen cannot therefore have come from the soil. The carbon can only have come from the carbonic acid of the air, the hydrogen from water, and the oxygen partly from water or other compounds and partly from the air. The source of the nitrogen was not so clear. Mineral matter could only come from the soil, but in this particular case a larger amount is added in the manure than is withdrawn by the crop.

The accumulation of data of this description enabled Liebig, in 1840, to solve the problem of plant nutrition, and to make the remarkable practical applications contained in his laws of manuring.

Up to the time when Liebig's laws were announced soil analysis had only limited application, and, on the whole, mechanical analysis was more useful than chemical. Thaer had, in 1808 (Grundriss der Chemie für Landwirthe), published a method of mechanical analysis, and suggested a classification of soils based on the results; Schübler, in 1838 (Grundsätze der Agricultur-Chemie), extended both method and classification; and a simple scheme for the farmer to carry out at home was given by the Rev. W. L. Rham in the first volume of the Journal of the Royal Agricultural Society (1840, p. 46). The idea underlying all these was that the fertility of a soil depended on the amount of water and air reaching the plant roots, or, in other words, on the physical properties of the soil. The analyst could do little more than recommend operations like liming, claying, &c., and the practical man generally knew from his own observation, and without outside help, whether these were needed or not. But a new light was thrown on the whole subject when Liebig announced that a full crop could be grown by supplying to the soil those mineral substances which are normally contained in the ash of the plant. According to this view, the whole art of manuring depended on a knowledge of the ash constituents of plants. Soil analysis showed which of these constituents are lacking in the soil; the analyst could now recommend suitable mixtures of mineral substances to make up the deficiencies, and was put in a position to render valuable help to the practical man.

ANALYSIS AS A MEANS OF TESTING SOILS, MANURES, FEEDINGSTUFFS, &c. — *Soils.* — The simple view of soil analysis just given is found to be attended with many difficulties in practice, and, at the present time, soil analysis is mainly used for purposes of comparison. The analyst examines the soil sent in, and compares it with similar soils of which he knows the agricultural value. Any differences are carefully studied, allowance is made, as far as possible, for any irregularity in temperature conditions and water supply, and a scheme of treatment devised. It is evident that the method has many limitations, and its value depends entirely on the completeness with which the standard soils have been studied. The great advantage of a well planned soil survey is that it furnishes the analyst with reliable information about typical soils in the area it covers, and enables him to institute a much more detailed comparison, and give more definite advice, than if no survey had been made. If a soil is sent from quite a new district, or from a formation with which the analyst does not happen to be acquainted, he has no standard for comparison, and can only give very general advice.

There are also other difficulties. It only rarely happens that the same type of soil persists over a large area, usually the soil varies within somewhat wide limits even on the same geological formation. Again, no proper allowance can be made for differences in temperature or water conditions, since these are influenced by a variety of factors—aspect, elevation, nature of the subsoil, &c.—which cannot be reduced to any exact formula. Even when the analyst has drawn up a scheme quite sound in principle, it may prove uneconomical in practice.

What, then, is the utility of soil analysis? It reveals any striking discrepancy between the soil in question and other soils known to be productive; and it suggests to the cultivator one or more schemes of manuring worth trying, to see if a profitable gain in crop can be obtained. Used in this way, soil analysis becomes a valuable help to the farmer.

Manures.—So long as dung and lime were the chief manures in use, there was no particular need for analysis. It became essential, however, as soon as commercial products were introduced, and the possibility of adulteration had to be reckoned with. Since the passing of the Fertilizers and Feedingstuffs Act in 1893, adulteration has become rare, but analysis is still necessary to see if the manures are up to guarantee. The Act of 1906 is more stringent, and a committee has been appointed to draw up standard methods to be adopted whenever proceedings under the Act are contemplated.

The analysis of manures differs from that of soils in that it is absolute, *i.e.* the actual percentage of the substance is found, and nothing is left to the judgment of the analyst. Difficulties arise when, in addition to a statement of composition, the farmer wishes to know the value to him of a manure. The analyst can, by means of the 'unit system' (see MANURES, ANALYSIS OF), effect a comparison with other manures of the same kind, and determine the market value of a particular sample, but it is usually very difficult to determine the agricultural value except by actual trial on the land. It would, for instance, be possible to say that a particular sample of fish guano was worth £6, 10*s.* per ton *compared with other fish guanos then being offered*, and that a particular meat guano, *compared with other meat guanos*, was worth £5, 5*s.*, but it would not be possible to say whether the fish guano is worth 25*s.* a ton more than the meat guano to the farmer.

The amount of phosphoric acid in a sample of mineral phosphate can readily be determined by analysis; the value of the mineral as manure, compared with other phosphates, can, however, only be discovered by field trials. In fact, any question involving the relation of the manure to the plant or soil requires for its solution more information than can be obtained from a mere analysis.

Feedingstuffs.—The present methods of analysis (see FEEDINGSTUFFS, ANALYSIS OF) are based on the investigations made by the celebrated German chemists Henneberg and Stohmann (Beiträge zur Begründung einer rationellen Fütterung der Wiederkäuer, 1860-64); they soon displaced the older methods of Thaer, Boussingault, and others. But, like the methods of soil analysis, they are, in the main, comparative, and are better adapted to comparing one foodstuff with another of the same kind than to stating explicitly the value of a particular foodstuff. An analyst could, for instance, readily say how far a particular linseed cake came up to the general standard, but he could not as easily say whether a new kind of seed would form useful food; for this purpose a feeding trial is necessary.

The difficulty arises from the fact that the examination is very incomplete, and the processes adopted do not measure quite definite substances. After the sample has been dried it is extracted with ether, and the substances removed are called 'oil', yet it is well known that much of the extract is not oil at all, but acid or other material. The sample is next treated successively with dilute sulphuric acid and with potash under definite conditions, and material resisting the attack of these agents is not considered likely to be attacked by the digestive fluids; it is called 'fibre', or 'indigestible fibre'. Later work has shown that the process is purely conventional; 'fibre' is not definite either in composition or amount, both are changed by altering the conditions of the experiment. It is not even indigestible; ruminants digest as much as 30 or 40 per cent, though whether they gain anything thereby may be doubted. The amount of protein is ascertained by assuming that it contains 16 per cent of nitrogen, and therefore multiplying the nitrogen found by $\frac{100}{16} = 6{\cdot}25$. The percentages of moisture, oil, fibre, protein, and mineral matter are finally added up, and the difference from 100 called 'carbohydrate' or 'nitrogen free extract'; it obviously embraces all the errors of experiment besides those involved in the preceding assumptions.

Yet, in spite of its conventional nature, the method gives excellent results, provided it is properly used, especially if it is combined with a microscopic search for foreign material.

[E. J. R.]

Analyst, Agricultural. — Specialization in agricultural analysis first arose in connection with the great agricultural societies, and subsequently the analytical associations, which sprang up in various parts of the country, especially in Scotland, led to further development in this direction. About the middle of the 19th century the use of artificial manures, and especially of guano, began to increase very rapidly, and to extend to the rank and file of farmers. It was in connection with these that the necessity for some definite system of analytical control was first recognized. The more enlightened agriculturists gradually came to see that these were substances the real value of which could not be estimated by the rough tests of eye and hand, but that they required expert chemical control if any check was to be put upon those who were unscrupulous enough to take advantage of the inability of ordinary people to detect adulteration. Hence the great agricultural societies placed facilities in the way of their members for having their manures and other substances analysed. So long as this system continued, the supply of agricultural analysts was small, and the protection afforded by the analysis of agricultural purchases was limited chiefly to the better educated and more opulent class of farmers. The poorer and more ignorant men, who most needed the help of the chemist, were left practically without protection. The Fertilizers and Feedingstuffs Act, 1903, was intended to remedy this, and to place within the reach of all farmers the assistance of the agricultural analyst. This Act required every County Council to appoint an agricultural analyst, officially known as the District Agricultural Analyst. While it was necessary for every County Council to appoint an analyst and to fix his remuneration, it was not necessary for the County Council to take samples or to see that the Act was put into force. The Councils, as a rule, arranged that farmers could have analyses under the Act made very cheaply, but the duty was not placed upon them to see that samples were taken and submitted to the analyst (see art. FERTILIZERS AND FEEDINGSTUFFS ACT).

The Act to a large extent remained a dead letter. In a few counties, samples were regularly taken, but in the great majority either no samples at all or very few were ever submitted to the agricultural analyst.

There were several causes for the failure of the Act of 1893, which were only to a limited extent connected with the analysts appointed. The main causes of failure were due to the machinery of the Act itself (art. FERTILIZERS AND FEEDINGSTUFFS ACT). When the Act was passed, there were very few analysts in this country with any extensive experience in agricultural chemistry. In the leading foreign countries, systems of agricultural research and education had already been developed, and as a part of the machinery large numbers of agricultural research stations had been instituted, in which a great number of chemists had been trained in chemistry in its bearings on agriculture. When the necessity arose, therefore, in these countries for control of the analytical fertilizers and other agricultural substances they naturally looked to the research stations, and in such countries as Germany and the United States a part of the work of the research stations is to analyse fertilizers, feedingstuffs and other purchases for farmers. In this country, before the Fertilizers and Feedingstuffs Act was passed, the Food and Drugs Acts were already in existence, and there were a large number of experienced analysts at work under these Acts. It was hardly to be expected that local authorities would recognize that an expert under the Food and Drugs Acts might not be an expert in agricultural chemistry, and might not have any special knowledge or insight into the requirements of agriculture. To them an analyst was an analyst, and, besides, there were very few qualified and experienced agricultural analysts in the country to whom they could go. Naturally, therefore, the public analysts were mainly appointed district agricultural analysts. Even in the highest official quarters the same mistaken policy was followed, and it was not recognized that great eminence as a chemist in certain other lines does not make up for want of knowledge and experience in agricultural chemistry. It is now generally recognized that one of the causes of failure of the Fertilizers and Feedingstuffs Act, 1893, was the want of a supply of agricultural analysts in whom local authorities and farmers alike had confidence.

In 1906 a new Fertilizers and Feedingstuffs Act was passed, which supersedes the Act of 1893. Under this Act the analysts are officially designated 'agricultural analysts' and no longer 'district agricultural analysts'. The methods of administration are greatly altered, and, in particular, power is given to County Councils to appoint official samplers and take samples without waiting for purchasers to take the initiative.

Two classes of samples are recognized under the Act—those taken in the prescribed manner, and unofficial samples taken without notice to the seller. Both classes of samples have to be sent to the agricultural analyst; but in the case of those of the first class the sample has to be divided into three portions, of which two are sent to the analyst and one to the seller, while in the case of unofficial samples the whole sample is sent to the analyst.

Under the Act of 1893 the whole invoice had to be sent to the analyst along with the sample. This has been modified in the Act of 1906, and the name or other matter which would identify the seller need not now be sent. The essential part of the invoice, however, that which gives the guarantee with which the goods were sold, must still in every case be sent. This provision has been very strongly objected to by farmers, and great efforts were made to have it left out in the Act of 1906. It is, however, quite essential to the working of the Act. The official duty of the analyst is to see that the sample corresponds with the warranty given in the invoice. Under the Act the seller must give an invoice, and that invoice must contain certain warranties prescribed by the statute. It is the duty of the analyst to see that the statutory warranty is correct, so far as the sample supplied to him is concerned. That he cannot do if he does not know what the warranty is. It is not necessary for him, however, to know who gives the warranty, and therefore, quite reasonably, the Act of 1906 does not render it necessary for the name of the seller to be sent. In the case of ordinary unofficial samples, the duty of the analyst is merely to return a certificate of analysis to the sender of the sample. He does not require to report further on the sample to any other person. The Board of Agriculture, however, has recommended local authorities to arrange with their analysts that all samples analysed should be reported to the local authority, and have stated that the Board will be glad to receive copies of all such reports. It is probable that all local authorities will fall in with this very wise request, which will enable the Board to prepare statistics of all samples analysed in all parts of the country, and to tabulate information concerning the kind of samples which are likely to be deficient in any way or fraudulent, and the sources from which such samples are derived.

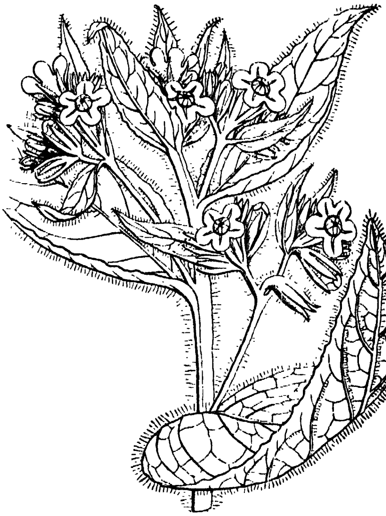
In the case of samples taken 'in the prescribed manner', which will probably come to be more shortly known as official samples, the duties of the analyst are more extensive. He must analyse only one part and retain the other. He must send a copy of his certificate to the person who submitted the sample for analysis, and if that person is not the purchaser, he must also send a copy to the purchaser and to the seller, and he must report, in a quarterly report prescribed by the Board of Agriculture, the results of all such analyses to the Board. In addition to all this, he must also report forthwith to the Board concerning any official sample, where any provision of the Act appears to him to have been infringed.

The Act of 1906 gives powers to the Board of Agriculture to make regulations as to the qualifications to be possessed by agricultural analysts. The Board have not as yet issued any regulations on the subject; but it is understood that they are prepared to recognize the possession of the Diploma of Fellowship or Associateship of the Institute of Chemistry, as proof of sufficient knowledge of analytical chemistry.

The Board are also given powers to make regulations 'as to the manner in which analyses are to be made'. So far they have exercised this power only to the extent of laying down the method which is to be used in extracting the citric soluble phosphate from basic slag and basic superphosphate. It is expected, however, that further regulations will be made at an early date. In this country we have as yet no official methods for agricultural analysis. Nearly all foreign countries have now adopted such methods for official purposes. Many of the determinations which have to be made in agricultural analyses are of a conventional kind, and the results depend to a considerable extent on the method of analysis adopted. It is most desirable, therefore, that in all such cases official definitions and methods should be provided to secure uniformity among official agricultural analysts. See also articles on FERTILIZERS AND FEEDINGSTUFFS ACT and FOOD AND DRUGS ACT. [J. H.]

Anatomy of Animals.—The domesticated animals, while differing largely in the digestive systems (see ALIMENTARY TRACT), have a common likeness to all vertebrates, with man at the summit: head, trunk, and limbs, brain, spinal cord, and nervous system, heart and circulation, digestion, and muscular clothing with bones as a foundation from which movements are effected. The anatomical resemblance of the anthropoid apes to man is even closer, but outside our province. The study of comparative anatomy enables us to identify the same materials as being employed in the construction of all quadrupeds as well as man. Histology, or the microscopic study of the tissues, proves them to be the same. The limbs of farm animals illustrate very well the modifications produced by varying environment, and by habits acquired through many generations. See the art. COMPARATIVE ANATOMY: see also under the various domestic animals Ass, HORSE, &c. [H. L.]

Anbury, a name for the fungoid disease of turnips and other Brassicæ, also called Finger-and-Toe. See FINGER-AND-TOE.



Evergreen Alkanet (*Anchusa sempervirens*)

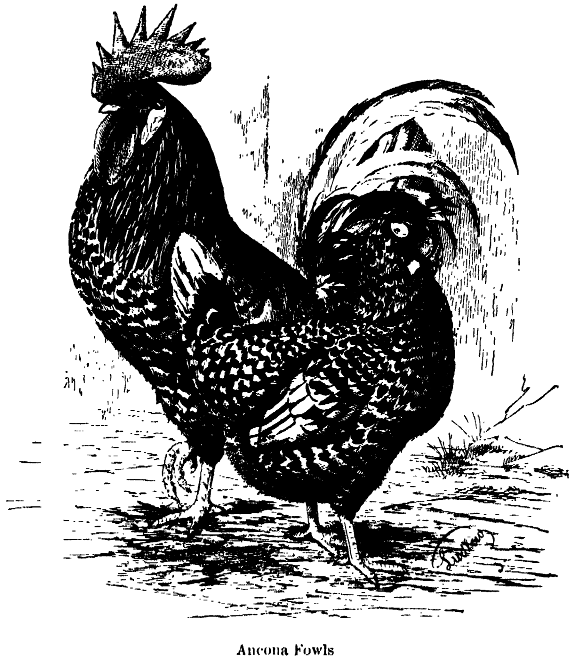
Anchusa sempervirens (Evergreen Alkanet or Bugloss).—This is a perennial rough-leaved plant, of the same nat. ord. as Forget-me-not (Boraginaceæ), which has been recommended as an early green crop for cattle. It has a thick, dark-brown underground stock, which produces a tuft of foliage that remains green all the winter, and annually throws up a stem about 18 in. high, covered with broad, ovate, succulent leaves, from among the uppermost of which appear close scorpioid cymes of small pale-blue flowers, with a white, hairy, five-lobed centre, formed by the ligules of the petals. When ripe, the fruit resembles small brown seeds, each of which has an ovate figure, and is marked with irregular lines.

This plant grows wild, here and there in waste places, in this country. It is insipid and mucilaginous, and said to be nutritious. According to French writers it is among the earliest of all green crops, growing from 18 in. to 2 ft. high by the middle of April. The leaves, which remain green all winter, are represented as being greedily eaten by horned cattle, and extremely useful for stall feeding.

The red dye called alkanet is furnished by the rhizomes of a Mediterranean species, called *A. tinctoria*, not suitable for cultivation in this country. [J. L.]
[A. N. M'A.]

Anchylosis, or Stiff Joint.—When the mobility of a joint is lost by reason of disease it is spoken of as a case of *anchylosis*, or stiff joint. It is a sequel to some previous disorder, and in general terms may be said to be incurable. Inflammations of joints or contiguous structures, resulting from blows or strains, occasion deposits of bony matter which more or less lock together the ends of the bones forming a joint. A familiar example is that of the horse suffering from ringbone, where the ossific deposition continues on the long and short pastern bones (*suffraginis* and *corona*) until any bending of the joint becomes impossible. Specific diseases affecting the joints of young creatures, foals, calves, and pigs in particular, lead to the deposit of morbid material which, becoming organized and permanent, deprives the affected joint of mobility. Owing to the danger of anchylosis, following even upon comparatively slight injuries in the neighbourhood of joints, they should always be deemed serious, and suitable treatment accorded without delay. For confirmed anchylosis there is no remedy. It is sometimes deemed desirable to promote the process by the actual cautery, or application of the firing-iron; after which there is a diminution of pain, or a callous condition, when it may be possible for the animal to walk about, and, if a horse, do slow work by throwing upon the other joints all the movements absolutely necessary for progression. In the case of cattle and pigs, a stiff joint or joints may not hinder them from breeding or seeking their food; but many horses have to be destroyed as unfit to work without pain. Stiff joints, in which actual permanent anchylosis has not taken place, may often be restored by the application of blisters or liniments, which excite absorption of inflammatory products interfering with mobility. [H. L.]

Ancona Fowl.—But for a series of circumstances, which need not be referred to, this race would have been included among the Leghorns, or Italiens as they are called upon the Continent of Europe. In Italy these are regarded as one and the same, an opinion justified by the general characteristics and qualities of the two breeds. From the fact that Anconas were imported into England more than fifty years ago, long before we had any Leghorns, they have always been accorded a distinct position. As the name indicates, they come from Eastern Italy, and it is more than probable that the first specimens were shipped from the port of Ancona itself. Birds of this type are found widely distributed in the district around that port, but the writer has found them very general in central Italy, more especially in some parts of Tuscany and

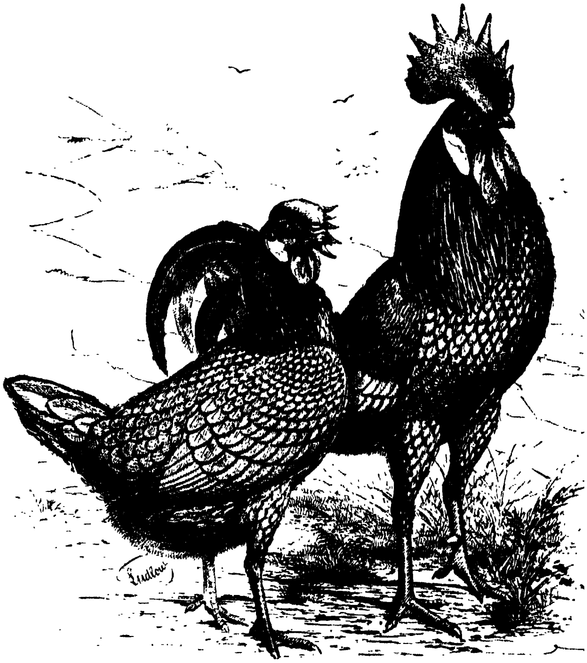


Ancona Fowls

Emilia. Generally speaking, the birds in those two provinces are called Mottled Italiens, and it may safely be assumed that these and the Anconas are one and the same. In some of the English Leghorns (see LEGHORN FOWL) there has been a very serious departure from the original type, but the Ancona has not been changed nearly to the same extent.

In general character the Ancona is very similar to the Leghorn, having a sprightly carriage, is active in habit, has a single comb (which falls over on one side in the hen), a long head, bright-red face, long neck, broad body in front tapering to the tail, medium length of leg, and a large tail in the male carried rather high. In a moist climate, such as prevails in the British Isles, the tendency is always to thickening of body, and, consequently, the birds of this race are fuller than they were when first introduced. The plumage has a brown-black ground colour, with creamy-white markings, which are, as a rule, clearly defined and fairly regular, but not showing the evenness found in other breeds such as the Hamburg or the Plymouth Rock. The legs are lemon-yellow, but are often mottled, and that is the original type; exhibitors, however, have unwisely tried to breed out the mottling.

The chickens of this race afford proof of the statement that it is allied to the Leghorn, as they are very precocious, and speedily able to take care of themselves. They are vigorous, active little creatures, quick in growth, and excellent foragers, whilst they are small eaters. The pullets commence to lay at an early age, if hatched at the right season of the year. Anconas are prolific layers, the eggs being of an average size. These are white-shelled, and fairly good in quality, with a tendency, however, to thinness of the albumen. The breed is essentially an egg producer, as they do not pretend to table properties. The quantity of flesh is small, and it is dry and fibrous, having the yellow colour which marks the Leghorn. They are very active and vigorous, and specially suited to colder and more exposed districts. Whilst they do better if given full liberty, many of the breeders of the Ancona keep them in confinement, where, if cared for in a suitable manner and given as much exercise as possible, they thrive excellently. [E. B.]



Andalusian Fowls

Andalusian Fowl.—At one time this race was commonly known as the 'Blue Spanish', due to the fact that it resembles in general character the breeds which have come to us from the Peninsula. It is, however, more nearly allied to the Minorca than to the Black Spanish fowl, as it has not the excessive development of white face which forms the principal feature of the last-named breed. The Andalusian is longer in the leg and slighter in build than the Minorca, and retains more of the original type. Generally speaking, it very closely appertains to the Mediterranean family, namely, it is upright in carriage, is compact in body, has longish neck and legs, and the head is surmounted by a large single comb, which falls over on one side in the female. The wattles are long and pendulous, and it has a white earlobe. The colour of the plumage is what is commonly called blue, although black predominates, for in the cock, the head, hackle, back, shoulders, wingbows, and saddle are of a lustrous black, whilst the breast, thighs, wingbars, flight and true tail feathers are of a silver-blue, each feather edged or laced with black. The sickle feathers are purplish-black. In the hen the greater part of the body is silver-blue with black lacing, the head and hackle being black. Thus, it will be seen, the female approximates more to the blue colour than the male. It is not our purpose to consider the question of coloration in the light of Mendel's Law, but it may be pointed out that blue is not a natural colour for the fowl, and it is perhaps the most difficult to produce and maintain. Andalusians are, consequently, very difficult to breed true, and the chickens very uncertain. However attractive that may be to the breeder for exhibition, it is not satisfactory to the ordinary poultry keeper.

There is another explanation why the Andalusian Fowl has not become generally popular, namely, that it is lacking in vigour of constitution. Perhaps it would be too much to say that it is delicate, but it certainly is unable to withstand the strain of a very cold or wet situation, in which respect the Leghorn is so eminent. A proof of what may be termed tenderness is seen in that the chickens are slow in growth and in feathering, and older specimens take a long time to pass through the period of moulting, thus resembling the Black Spanish especially, although the Minorca evinces the same tendency. Hence these birds do not succeed well except in warm and sheltered positions, where they can be protected against wind and rain, and the soil is of a kindly nature. Considering the excellent quality referred to below, the reason why the Andalusian has not won a greater amount of favour is due to the fact just named, and that the chickens are somewhat difficult to rear, more especially in the colder sections of the country.

The Andalusian is pre-eminently an egg producer, in which respect, both as to number and size of egg, it occupies a very high position among domestic fowls. For some reason that has never been explained, all the Spanish races produce large eggs, and the Andalusian is certainly one of the best in that respect. The shells are pure white, but the bulk is due rather to a greater proportion of albumen, which in large eggs is often thin, than to a larger yolk, in which case size is obtained at the expense of flavour and quality, but purchasers like to see big eggs. Young hens of this breed will often give 150 eggs per annum, weighing from $2\frac{1}{4}$ to $2\frac{1}{2}$ oz. each. As is the case with all the Italian and Spanish races, they are poor in table properties, except when very young, and on more mature birds the flesh is dry as well as scanty.

[E. B.]

Anderson, James, LL.D., an agricultural writer of some eminence, was born at Hermiston, near Edinburgh, in 1739, on a farm which had been in the possession of his family for some generations, and which it was intended he should inherit and cultivate. His interest in agricultural science and practice, thus early awakened, he maintained unabated throughout his life. His parents died when he was quite young, but his education was not neglected. Finding in the perusal of Hume's works on agriculture much that was beyond his comprehension, he eagerly availed himself of the courses of studies in Natural Science then open to him, particularly in the science of chemistry, and thus fostered the spirit of investigation with which he seems to have been imbued.

His studies completed, he left the Edinburgh farm for one in the county of Aberdeen, which he cultivated for twenty years, and improved to such an extent that he was enabled to retire, on the annuity it provided, to Edinburgh, there in the ripeness of experience to devote himself to the publication of the results of his observations and investigations. His writings, of which a selection is appended, found a wide acceptance, and gave a considerable impetus to the then expanding current of agricultural progress. His latter years were spent at Isleworth, near London, where he died in 1808.

Works:—Essays relating to Agriculture and Rural Affairs. Miscellaneous Thoughts on Planting and Training Timber Trees, 1777. An Account of the Present State of the Hebrides and Western Coasts of Scotland. A Practical Treatise on Peat Moss. A General View of the Agriculture and Rural Economy of the County of Aberdeen. A Practical Treatise on Draining Bogs and Swampy Grounds. Recreations in Agriculture, Natural History, &c.

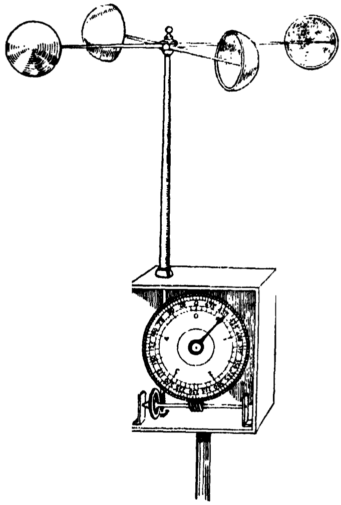
[J. B.]

Anderson, Thomas, M.D., LL.D. (1819-74), a chemist, distinguished alike for his eminence in collegiate and scientific circles and for his valuable research and experimental work in the domain of agricultural chemistry. He was the son of a Leith physician, and it may be presumed that his early associations all tended to give a more or less chemical bias to his mind. Even in the early years of his medical studies his interest was chiefly centred on the chemical aspects of his prospective profession, and his thesis for the degree of M.D., which he obtained in 1841, was entitled 'The nature of the chemical changes which take place in secretion, nutrition, and other functions of living beings'. After completing his studies in Edinburgh he went to the Continent and studied under Berzelius and Liebig. His career on returning to Edinburgh was marked by a succession of appointments and honours, culminating in his election in 1867 as President of the Chemical Section of the British Association for the Advancement of Science. From 1852 onwards he occupied the Chair of Chemistry in Glasgow University; but it is in his capacity as chemist to the Highland and Agricultural Society that he deserves a place in the roll of agricultural biographies. This position he held from 1848 to within a short time of his death, in 1874. His reports on analyses of manures, feeding-stuffs, soils, &c., formed yearly contributions to the Society's Transactions of that time, and in 1860 he published The Elements of Agricultural Chemistry, a textbook which still possesses some value. He also conducted investigations into the composition of wheat, beans, and turnips at different stages of their growth. [J. B.]

Andesite.—A very common type of igneous rock, intermediate in chemical composition between trachyte and basalt, with a ground containing some glassy matter. The typical masses occur as lava flows, and the name was given to them by Roth, in 1861, from their abundance in the Andes mountains. Those with about 60 per cent of silica or less yield ferruginous clayey soils when thoroughly decomposed, in which crystals of soda-lime felspar, augite, mica, &c., form granules. (See arts. CLAYSTONE and PORPHYRITE.) Other andesites represent, in a partly glassy form, the crystalline quartz-diorites, and may even contain crystals of quartz, which contribute a more permanently sandy character to the soil. [G. A. J. C.]

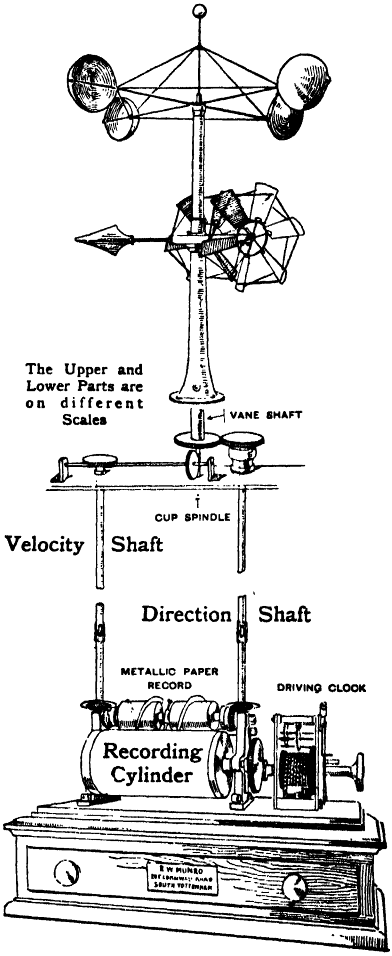
Andricus (Oak Galls).—A group of Cynipid gall insects which attack oaks. See CYNIPIDÆ. [F. V. T.]

Anemometer.—An instrument for measuring the velocity of the wind. Various instruments have been devised for this purpose, but the one most commonly adopted by meteorological stations is after the type invented by Dr. Robinson of Armagh, which is here illustrated. Four hemispherical hollow cups are attached to the ends of two horizontal arms attached rigidly at right angles to the top of a vertical spindle or rod, forming an axis which can revolve freely. The mouth of each cup is turned towards the bottom of the next in front, so that in whatever direction the wind may blow it is always received by the hollow of the cups on one side of the spindle, and strikes against the hemispherical bottom of those on the other side. The wind thus always acts with greater force on one side than on the other, driving the cups round in a constant direction at a rate which affords a measure of the velocity of the wind. The lower end of the supporting spindle is provided with a worm and a series of accurately-made cog-wheel dials which record the number of miles travelled by the wind. Dr. Robinson found by experiment that the rate of revolution of the cups was almost exactly one-third of the velocity of the wind. The chief drawback to this instrument arises from the inertia of the arms and cups, which causes it to register much higher velocities during gales than is probably attained by the wind.



Beckley's Improved Robinson Cup Anemometer

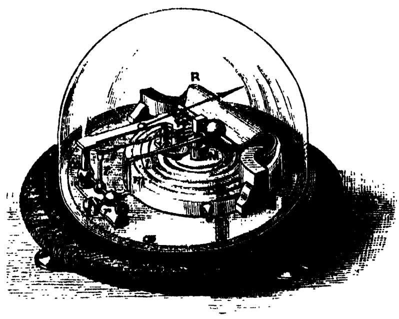
The *anemograph* is a self-registering anemometer. A register sheet is wrapped round a cylinder, which revolves by clockwork at a uniform rate once in twenty-four hours. Two pencils are in gentle contact with the surface of the paper, one acting over one-half of the cylinder and recording the velocity, and the other acting over the other half and recording the direction. The corresponding halves of the register sheet are each marked by vertical and horizontal lines, the vertical lines indicating in the one case the number of miles passed over by the wind, and in the other the changes in the direction of the wind, and the horizontal lines indicating the time taken in both cases. [J. B.]



Robinson's Anemograph, Kew Pattern

Anemone.—A genus of handsome herbaceous perennials, nat. order Ranunculaceæ, some valuable for the border and wild garden, some for spring bedding, and others for the alpine garden. The most useful is *A. japonica*, which will grow in any soil and almost any position, and yield an abundance of lasting handsome flowers in the late summer and autumn. There are rose, white, and double varieties. *A. hortensis*, better known as *fulgens*, or the Scarlet Windflower, is rather tender, but in sheltered situations it produces in May a brilliant display of attractive bright-scarlet flowers. In the south of England it is a first-class border plant. The Poppy Anemone (*A. coronaria*) is an old garden plant which does not find as much favour as it deserves. In a good soil, under the shelter of a wall, when once planted it will hold its own for many years, and during April and May flower with the greatest profusion. The colours of the flowers are of all shades, from white to crimson and dark-purple. They ripen seeds, which should be sown at once and treated like stocks and asters. The plants flower when about a year old. The smaller species, namely, *A. apennina*, *A. blanda*, *A. hepatica*, *A. nemorosa*, and *A. Pulsatilla*, are excellent plants for the rockery or wild garden. They all like a moist situation and a strong, loamy soil. They are easily multiplied by division of the rootstock after the growing season is over. A suitable place for these smaller anemones is under roses or Ghent azaleas or other deciduous *shrubs, where they will come into flower early in the year and not interfere with the shrubs* or the shrubs with them. *A. Pulsatilla* grows *well, and looks charming when planted along* with hardy ferns. [W. W.]

Aneroid.—In the aneroid barometer, as its name implies (Greek, *a*, not; *nēros*, liquid), no fluid is employed, the action being dependent upon the susceptibility to atmospheric pressure shown by a flat, circular metallic chamber from which the air has been partially exhausted, and which has a flexible top and bottom of corrugated metal plate. By an ingenious arrangement of springs and levers the depression or elevation of the surface of the box is registered by an index on the dial, by which means it is also greatly magnified, being given in inches to correspond with the mercurial barometer. Aneroids are, however, generally less reliable than mercurial barometers, with which they should be frequently compared. The cut shows an aneroid without its case. At the centre of the upper surface of the metallic chamber above referred to is a small pillar M, connected with a powerful steel spring R. The rise or fall in the top of the box due to changing atmospheric pressure is transmitted by means of the levers *l* and *m* to a metallic axis *r*; and this axis carries a lever *t*, whose end is attached to a chain *s*, which turns a drum on whose axis the index-needle is fixed. The chain is kept constantly stretched by means of a spiral spring. [J. B.]



Interior Mechanism of Aneroid Barometer

Anethum. The botanical name for the plant called Dill. See DILL.

Aneurism.—A diseased condition of an artery in which there is local dilatation and partial rupture. Strain upon the vessels is the chief cause in horses, and parasitism in some other species of animals. Continuous pressure brings about repair, and is often practised on men by relays of students or nurses employing their fingers. In the case of animals we have to be content with such pressure as can be obtained by bandages, or by ligaturing the vessel above and below the sac. Blood pressure is lowered by aconite, and absorption promoted by iodides. Low diet and rest are recommended. [H. L.]

Angevin Cattle.—The name 'Angevin' was formerly used by butchers and stock salesmen to denote a class of cattle brought to the Paris market from the grazing district of Anjou. The use of this collective term has now been almost discontinued, and the cattle are now called by the specific breeds to which they belong.

Angevin Horse.—One of the French breeds of horses, which seems to have been derived from an old race of horses having its home in the province of Anjou, by crossing with the English Thoroughbred or the Anglo-Norman breed. The characteristics of the breed vary somewhat, but the best type is symmetrical in conformation, with a well-formed head nicely attached to a rather heavy, low-set body. The legs show good bone, and the action is quick and regular. The breed is a hardy one, and has been growing in importance of late years.

Angevin Pig.—A name sometimes applied to a breed of pigs which obtains largely in the neighbourhood of the town of Craon, in the province of Anjou, and commonly known to French agriculturists as the 'Craonais' breed. See art. CRAONAIS PIG.

Angleberries or Warts.—These consist mainly of piled-up epithelium, but what causes them is not known. Encysted tumours are also called warts, and may for convenience be considered here. Angleberries often grow to great proportions on cattle, favouring the flanks and belly, but to be found in other parts.

Treatment depends upon the shape and disposition of the growths. The pedunculated are best destroyed by strangulation, for which purpose silk, thread, twine, waxed ends, and other substances suited to the size and consistence of the excrescence may be employed. The broad-based or spreading warts are disposed of by applications of various caustics, as arsenical soap, chloride of zinc, nitrate of silver, &c.

Warts occurring around the eyes and lips, and upon the teats of cows, may be removed less quickly, but effectually, by the safer preparations of salicylic acid in collodion, or solution of potash.

Encysted warts are cut down upon and squeezed out by the fingers, after which the sac heals up without need of further treatment, unless, as sometimes happens, they are multiple, and many minute grain-like bodies are already forming to take the place of the larger growths. The common belief that the blood from a wart, as it runs over the skin, is an exciting cause of fresh growths, has more than a foundation in fact, according to competent observers.

[H. L.]

Anglesea Cattle. See WELSH BLACK CATTLE.

Angora Goat.—This breed differs considerably in appearance from the common goat, carrying as it does a thick white fleece of a silky texture, which terminates in long ringlets, and envelops the animal from the base of the horns down to the hocks. Unless shorn, this is shed annually in summer like wool in sheep, and is known commercially as 'mohair', hence this breed is often referred to as the 'Mohair goat'. In addition to this outer covering there is usually an undergrowth of hair, more or less abundant, called 'kemp'. As this material, however, detracts from the quality of the clip when sold, it is the great object of the farmer to eliminate it as much as possible in breeding, consequently in the best and purest specimens this hairy growth, which is of a permanent nature, is scarcely perceptible. The horns of the Angora are flat-shaped and taper towards the extremities, taking a spiral form, which in the male is usually more pronounced than in the female. The ears are rather wide and droop forward, but are never actually pendent like those in the Nubian and other eastern varieties.

Angora Goat

on among naturalists as to whether this breed is descended from *Capra ægagrus*, the wild goat of Persia, or from *Capra Falconeri*, the Markhor wild goat. The latter theory has been adopted by some authors on account of the apparent similarity in the conformation of the horns, the Angora being the only domestic breed in which a spiral twist is observable. There is, however, a certain difference, inasmuch as in the horns of *Capra Falconeri* the spiral twist is invariably outwards, whilst in those of the Angora it is invariably inwards. Pallas believed the Angora to have been produced originally from a cross with the sheep, a view entirely rejected by naturalists of modern times, though many writers recognize points of similarity between this kind of goat and the sheep. Whatever the origin of the Angora may have been, there is clear evidence that it is a breed of considerable antiquity, as fleece-bearing goats were kept by the Egyptians and the Persians at remote periods.

The Angora goat takes its name from the town and province of Angora, in Asiatic Turkey, where for centuries large flocks of these animals have been reared to carry on the trade in mohair. The actual mohair district, however, extends to the neighbouring provinces, and consists of mountainous regions and elevated plateaux some 2500 feet above sea level. The extent to which goat-farming is carried on in this neighbourhood may be gathered from a recent statement that there were 1,230,000 Angora goats in the province of that name.

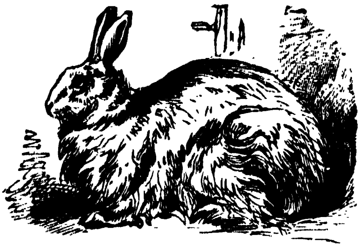
The Angora has often been confounded with the Cashmere, although there is very little in common between the two breeds. Both kinds have been imported to the Cape, but the attempt to establish the Cashmere was after a time abandoned in favour of the Angora, which was successfully introduced in 1838 by Colonel Henderson, who brought the goats from Bombay. The success of the enterprise has been so great that goat-farming is now general throughout the Colony, and far more mohair is imported from the Cape than from Asia Minor. Importations of the Mohair goat have also been made at various times into America. The first consignment took place in 1848, when the Sultan of Turkey made a present of nine of the choicest specimens to Dr. J. B. Davies of South Carolina, in return for services rendered in Turkey in experimenting in the culture of cotton. Large herds are now farmed in the States, chiefly in California and Texas, where, in addition to the establishment of the mohair trade, the goats have been found extremely useful in clearing off the brushwood from fresh tracts of land.

[H. S. H. P.]

Angora Rabbit.—The Angora is distinguished from all other rabbit breeds by its long, fine, fleecy coat, which resembles wool rather than hair or fur, and is disposed in thick clusters all about the body and head in such a way as to obliterate the form of the animal, and give it the appearance of a large woolly ball.

The Angora is a little larger than the Dutch and Himalayan, although from its fleecy coat it looks larger than it really is. The colour preferred by fanciers is white; the eye pink—of a paler hue than that of the Himalayan. The latter is also more compactly built, firmer in the flesh, and stronger in the legs.

The management of this breed does not differ materially from that of other breeds (see art. RABBITS). It must be borne in mind, however, that the Angora is rather delicate in constitution, and care must accordingly be taken not to expose it unduly. Matting of the wool sometimes causes trouble. To avoid this, brush regularly, and whenever the tendency to matting shows itself, ease it out with a little warm water. These precautions will, however, avail nothing if strict cleanliness is not observed. The hutches should be kept dry, and cleaned out at least three times a week, and crowding should be avoided, although, being of a gentle and amiable nature, there is no objection to keeping a number together if the accommodation be sufficiently roomy.


Angora Rabbit

Angoras are occasionally kept in large numbers for the sale of their wool. This is removed by hand or by combing three or four times a year, the combings being preserved till a marketable quantity is obtained. Smaller quantities may be used for sofa cushions and similar fancy articles, for which it is very suitable.

Anguillulidæ. - A family of Nematoda or Threadworms of microscopic size, which live upon organic substances. They may be found free in the soil amongst decaying vegetable matter, sometimes occurring here in very large numbers; very commonly they occur in the tissues of living plants, where their presence has usually, owing to their large numbers, very injurious effects. Some are known to live in organic fluids, *e.g.* the familiar 'vinegar or paste eels' (*Anguillula aceti*); several species of another genus (*Strongyloides*) of this family have been found in the intestine of sheep, pigs, and even man. The life-histories of most species are only imperfectly known, but it is probable that those parasitic in plants have a free living stage in the soil. This is the case at all events in some which are of importance in agriculture. The best-known forms are the stem eel-worm (*Tylenchus devastatrix*), which is one cause of 'clover sickness', and which attacks various other plants, *e.g.* oats, wheat, beans, onions, as well as various grasses and other wild plants. 'Ear cockles' or 'purples' in corn, where the grains are replaced by galls containing eelworms, is due to a related species (*Tylenchus tritici*). Analogous diseases are caused in the roots of tomatoes and cucumbers by the presence of *Heterodera radicicola*, a related genus, and there are several others known to be injurious to cultivated plants. These worms appear to possess considerable powers of resisting desiccation, they may live dried for several years; some are known to resist animal digestion, passing to the soil, whence they may again enter living plants. See STRONGYLUS, TYLENCHUS.

[J. R.]

Animal Charcoal. See CHARCOAL.

Animal Chemistry.—Farm animals obtain the requisite food constituents for their development from the nutritive substances present in plants, and from the components of the atmosphere. It is thus plain that the elements composing the animal body must closely approximate to those found in plants. The fifteen elements mainly associated with plant and animal life are carbon, oxygen, nitrogen, hydrogen, sulphur, phosphorus, potassium, sodium, chlorine, calcium, silicon, magnesium, fluorine, iron, and manganese. Though found in both the vegetable and animal kingdoms, the abovenamed elements do not necessarily exercise in both cases the same important functions. Compounds of sodium and chlorine occur in succulent and other crops, and it is well known that many plants can thrive well without them, yet united together as common salt both are indispensable in the development of the animal body. In the same way, fluorine appears to be essential in the formation of the hard portions of the teeth and bones of animals, whilst it is of very minor importance to plants. The elements composing animal substance are not present in the free state, but associated with each other in various combinations to form distinct chemical compounds. A knowledge of the composition, properties, and source of these compounds is a matter of considerable importance if we are to understand the relationship of food to animal nutrition.

In the first place, the animal body may be roughly divided into the fluid and liquid portion. The fluid portion, which consists of the blood and other animal secretions, is variable, and may amount to between 4 and 9 per cent of the live weight of the animal. There is less in old and fat than in young and lean animals. The solid portion is made up of bones, which form from 6 to 12 per cent, muscles and tendons, &c., from 35 to 40, and fat, which is extremely variable, and may range from 4 to 40 per cent of the weight of the body. Though the fluids only amount approximately to the above figures, they by no means represent the amount of water contained in animal substance, for it must be borne in mind that the material comprising the solid portion of the body consists, to a very large extent, of water. Fresh bones contain between 20 and 50 per cent, whilst muscle contains from 60 to 75 per cent of their weight of water.

Directly after birth, the body contains from 80 to 85 per cent of its total weight of water.

This amount decreases to about 60 per cent as growth rapidly proceeds, whilst in the mature or fat animal the total weight of water present falls to between 40 and 45 per cent. This change in the water content of the body, according to the stage of growth of the animal, naturally affects the composition of all the other organs. Bones are affected most, and blood least. Thus the bones of a new-born animal contain about 70 per cent, whilst those of a mature animal containing about 20 per cent of their weight of water. From these figures alone it will be observed that water must play a very important part in animal nutrition.

The dry matter of the animal is that portion left after the water has been evaporated away. This, as in the case of plants, consists of a combustible and a non-combustible part.

The combustible part is composed principally of fat and nitrogenous compounds. The former contain the elements carbon, hydrogen, and oxygen, whilst the latter contain in addition nitrogen, a little sulphur and sometimes phosphorus. Besides water, the body is largely composed of these combustible or organic substances. Taking first the compounds containing nitrogen, they may be regarded as falling under three headings, namely, albuminoids, gelatinoids, and horny matter.

The albuminoids are by far the most important. They form the principal substance of the brain, muscle, nerve, and solid portion of blood. Of all the compounds of the body they are most directly associated with the phenomena of life. They are very complex bodies. Their composition may be represented as falling within the following limits:—

Carbon	51·5	to	54·5	per cent
Hydrogen ...	6·9	,,	7·3	,,
Oxygen	20·9	,,	23·5	,,
Nitrogen	15·2	,,	17	,,
Sulphur......	0·3	,,	2·0	,,

The types of albuminoids occurring in the body are albumins, fibrin, and casein. Albumins occur principally in the blood and other secretions of the body, fibrin in the blood and flesh, and casein in milk. For further information upon albuminoids the reader must consult the articles on Albuminoids and Proteids.

Gelatinoids are closely allied to albuminoids. They form the nitrogenous substance of bones, cartilage, skin, tendons, and connective tissue.

Horny matter includes the material of which horn, hair, wool, feathers, &c., are composed. The chemical constituent of this horny matter is called keratin. This substance is closely allied to, but contains more sulphur than proteids.

Besides the nitrogenous compounds already mentioned, a number of non-proteid nitrogen compounds, called extractives, are found in the various juices of the body and in water, the principal being creatin, creatinin, sarcine, &c. In addition to these, bodies called amides also occur. They are derived from albuminoids, and appear mostly in the liquid excreta.

Of the non-nitrogenous components of the body, fats are the most abundant. In a well-developed animal scarcely a tissue could be found devoid of fat; its storage, however, takes place more particularly in the cells of the connective tissue. Fats obtained from different organs of the body vary very slightly in chemical composition. Greater differences in their qualitative rather than their quantitative composition are found to exist. This is the case in different species of animal, also in the different organs from the same animal. It is well known, also, that some foods rich in fats, when fed to animals, may give to the animal fat thus stored up in the body or contained in the milk certain distinct chemical properties. Animals appear to have some power of selecting certain fats in the food for storage in the body, and also of transforming one fat into another. Some of the principal fats are stearin, palmitin, olein.

Carbohydrates, to which class of compound sugars belong, occur to a much less extent than fat in the animal body. They exist principally in the blood and liver; in the former mostly as dextrose or grape sugar, in the latter as glycogen or animal starch. Organic acids, either as salts or in the free state, exist even to a smaller extent in animal substance.

The incombustible portion, or ash, is composed of the mineral or inorganic constituents of the body. According to Wolff,

Cattle	contain from	4	to	5 %	of their live weight	of ash.
Sheep	,,	2·8	,,	3·5	,,	,,
Pigs	,,	1·8	,,	3·0	,,	,,

The ash constituents of animals are similar to those of plants. They are found in nearly all organs of the body, but occur most abundantly in bones. In the fat animal about 80 per cent of the total ash constituents are present in the bones. Bone ash contains about seven-eighths of its weight of tri-calcium phosphate. About four-fifths of the total ash of the body also consists of this substance, the remainder being made up of soda, potash, iron, chlorine, magnesium, sulphates, carbonates, and traces of silica. Potash and soda are excreted in the urine, wool, and in perspiration. Both are essential constituents of animal secretions. The latter, in the form of common salt, plays an indispensable part in the process of digestion, the former is more particularly associated with cell formation. Iron is a constituent of hæmoglobin, the red colouring-matter of blood.

Lawes and Gilbert have made exhaustive chemical analyses of the bodies of many farm stock, the results of some of which are given in the tables on p. 132.

The analyses in the tables show some salient differences in chemical composition among animals according to species, age, and condition. The Rothamsted results show that in a fat ox about 60 per cent of the fasted live weight will be butcher's meat, in a fat sheep about 58 per cent, and in a fat pig about 83 per cent. The proportion of carcass, however, increases during the fattening of an animal; thus the carcass in a store sheep averaged 53·4 per cent, fat sheep 58·6 per cent, and in a very fat sheep 64·1 per cent of the fasted live weight.

PERCENTAGE COMPOSITION OF WHOLE BODIES OF ANIMALS

	Fat calf.	Half-fat ox.	Fat ox.	Fat lamb.	Store sheep.	Fat sheep.	Extra fat sheep.	Store pig.	Fat pig.
Water	65·1	56·0	48·4	52·2	61·0	46·1	37·1	58·1	43·0
Nitrogenous matter	15·7	18·1	15·4	13·5	15·8	13·0	11·5	14·5	11·4
Fat	*15·3*	*20·8*	32·0	31·1	19·9	37·9	48·3	24·6	43·9
Ash	3·9	5·1	4·2	3·2	3·3	3·0	3·1	2·8	1·7

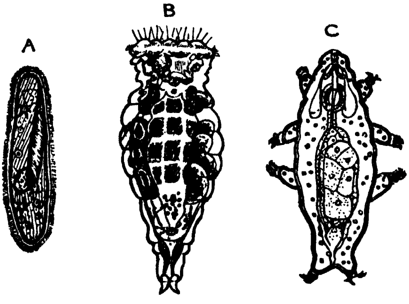
ASH CONSTITUENTS AND NITROGEN IN 1000 LB. OF VARIOUS ANIMALS AND THEIR PRODUCTS

	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesia.
	lb.	lb.	lb.	lb.	lb.
Fat calf	24·14	15·35	2·06	16·46	0·79
Half-fat ox ...	27·45	18·39	2·05	21·11	0·85
Fat ox	23·26	15·51	1·76	17·92	0·61
Fat lamb	19·71	11·26	1·66	12·81	0·52
Store sheep ...	23·77	11·88	1·74	13·21	0·56
Fat sheep	19·76	10·40	1·48	11·81	0·48
Store pig	22·08	10·66	1·96	10·79	0·53
Fat pig	17·65	6·54	1·38	6·36	0·32
Wool unwashed ...	54·00	0·70	56·20	1·80	0·40
Wool washed ...	94·4	1·80	1·90	2·40	0·60
Milk	5·76	2·00	1·70	1·70	0·20
Hens' eggs... ...	20·00	4·22	1·75	60·82	1·09

Reference has already been made to the similarity in composition between the substances which go to build up the plant and animal body. Plants assimilate their food from the soil water and from the atmosphere in the form of simple substances. These, by the help of the sun's energy, are further synthetically manufactured into the numerous complex compounds of which plants are made. Though varying in chemical composition, these substances possess one thing in common, that is, they all contain a store of potential energy. It is in the manufacture of the complex organic compounds from simple ones that the vital processes of life are manifested. All forms of life are, as far as is known, associated with such changes. It is generally believed that animals have not quite the same power of synthetically building up substances as that possessed by plants, yet they are endowed with this property to a very marked extent. The food of farm animals consists of the highly complex bodies called albuminoids, carbohydrates, and fats, which have been manufactured and stored up by plants. Before these substances can play any part in animal nutrition they undergo the process of digestion in the alimentary canal, which process converts them into assimilable forms. When in circulation in the blood, they are subject to the action of the vital processes associated with the building up of animal matter. Indispensable to these organic changes is a supply of oxygen, which gets into the animal system from the atmosphere through the lungs. The transformations and decomposition undergone in the body by the chemical compounds in their function as foods are still wrapped in mystery. In their passage through the animal system some are oxidized and broken down into simple gases, evolving in the process heat and energy to supply the body with warmth and motive power, whilst others are subject to the metabolic changes, which result in the production of new tissues, and generally repair the waste that is going on in the old. In this way, plant substances act as food to the animal. See also arts. on FOODS and NUTRITION.

[R. A. B.]

Animalcules.—The term is used to describe various minute forms of animal life, which belong to several different divisions of the animal kingdom, but which agree in their comparative smallness of size and in their relatively similar habits and habitat. They all exist in fluid media during the active phases of their life, but are capable of resisting desiccation, whereby they tide over periods of drought and are disseminated by the winds. Thus it comes about that in the open sea, in every stream or piece of stagnant water, or even temporary pool, provided organic food is present, these minute forms of life appear and multiply. The larger



Animalcules

A, Paramœcium, the Slipper Animalcule. B, Hydatina, a common rotifer. C, Macrobiotus, the Water Bear.

examples are just visible to the naked eye; most, however, are strictly microscopic. Some are pigmented, but the majority are colourless. In matters of diet they vary, and all types abound. Some are vegetarian, feeding on microscopic plants, *e.g.* unicellular algæ, or upon bacteria; others are saprophytic, devouring decaying animal or vegetable matter; others are strictly carnivorous, attacking their fellow animalcules. Omnivorous types are common, and here, as in higher spheres of life, parasites abound. All grades of activity are represented also. There is the swiftly-moving ciliated Infusorian, which darts across the field of microscopic vision like a flash, and which must be transferred to a mixture of glycerine and water before its progress can be sufficiently impeded to admit of its structure and activities being studied. At the other extreme may be placed the sluggish, leisurely Amœba, which may be watched creeping about within a drop of water, a formless speck of jelly-like protoplasm, pushing out at any part of its cell body a finger-like part—a pseudopodium — retracting it or pushing out others alongside, in this way enveloping particles of food or making progress within its somewhat limited sphere of action. Between these extremes there are all grades of activity.

As already indicated, the term animalcules is not applicable to a particular zoological type, but is a general term descriptive of microscopic animals of various kinds. Notwithstanding this, it is on the whole customary to confine the term to the Protozoa, Rotifera, and Tardigrada. Of the Protozoa or single-celled animals may be quoted the well-known slipper animalcule, the ciliated infusorian Paramœcium. It may be readily obtained by making infusions of hay, or from water in which cut flowers have been allowed to stand at a room temperature for a few days. Another common example is the green Euglena, which occurs in liquid manure. A large Rotifer which feeds upon Euglena, and well known amongst animalcules, is *Hydatina senta.* It is big enough to be seen by the unaided eye. Rotifers are highly organized creatures, though minute, agreeing in many details of structure with the higher worms. The Tardigrada or water bears are quaint, interesting creatures allied to mites, with four pairs of short, stump-like clawed legs. In their shape and movements these animalcules greatly resemble bears. They occur commonly amongst moss, in the mud of ponds, and in the dust of gutters, or in the crevices of rocks and stones. They can not only revive after prolonged desiccation, but can withstand asphyxiation for a time. Animalcules are of world-wide distribution. [J. R.]

Animal Heat. — Animal heat is derived from the combustion of animal cell substance, this combustion being an essential element of vital activity. The process by which heat is formed consists in the oxidation of complex molecules of proteid, fat, and carbohydrate. It takes place throughout the body, and all organs share, although not equally, in its production. The cross-striped muscles are most important in this respect. In healthy warm-blooded animals, *i.e.* birds and mammals, the body heat is maintained with remarkable constancy, independently of the temperature of the external medium, and is always higher than it. Different species of warm-blooded animals have, however, distinct body temperatures; in general, that of birds is higher than that of mammals. The former is known to range from 39·4° to 43·9° C., and the latter from 35·5° to 40·5° C.; that of man is 37·5° C. In the case of cold-blooded animals, the temperature of the body is not maintained independently of the external medium, but rises and falls with it. In a moist medium it may be slightly higher, but in dry air is generally lower.

Although the temperature of warm-blooded animals is remarkably constant, there are individual variations. In man this variation is slight, amounting only to fractions of a degree. Fluctuations of temperature take place in correspondence with varying activities; after a meal or violent muscular effort there is a rise, while mental effort, physical inactivity, or the swallowing of cold water, and such like are succeeded by a fall. Heat is constantly being gained and lost, and the relative constancy in amount which is maintained is regulated by several factors. The amount of heat produced depends upon the amount of muscular exertion indulged in, and the amount and character of the food consumed. This heat is partly dissipated by conduction and radiation from the surface of the body, by the evaporation of moisture from the lungs and air passages and from the skin, and in the liberation of carbon-dioxide from the lungs. It is also in part absorbed in raising the temperature of food and drink when taken into the body. It is estimated that in the case of an adult man 80 per cent of the heat loss takes place through the skin. The natural coverings of the animal body, viz. fur and feathers, and in the case of man his clothing, materially restrict this loss by the skin, as also does the subcutaneous fat, which is a poor heat conductor. The actual regulation of loss from the surface of the body, however, is effected by the control of the amount of blood supplied to the skin. The more blood appearing here, the warmer the surface of the body becomes, and there is consequently the greater loss by conduction and radiation. The surface vessels are constricted or dilated by the stimulus of the vasomotor nerves, and thus the amount of blood reaching the skin is maintained in accordance with the requirements of heat regulation. The maintenance of the regulation body temperature in an atmosphere which is much higher than that of the body itself is effected by the secretion of sweat, which absorbs a large quantity of heat from the skin. Thus the body is cooled, even although the surrounding temperature is higher. [J. R.]

Animal Kingdom.—It has long been customary to speak of natural objects as belonging to the three kingdoms, animal, vegetable, and mineral. The results of modern research, while in general tending to the removal of arbitrary lines of demarkation, cannot be said, notwithstanding remarkable discoveries in the realm of the constitution of matter, to have done much, if anything, to break down the barrier between the not-living mineral kingdom and the living animal and vegetable world. While this is so, we are well aware that down at the bottom of the scale of living things it has become increasingly difficult to distinguish between animal and plant. The barrier, indeed, is broken here, and we are forced to recognize amongst the lowest forms of life, organisms which have equal claims to be regarded as either animal or plant. They bridge the gulf, these Protista as they have been termed, between the distinctively animal and plant organisms. They mark the place of divergence of these two now widely separated streams of life.

Neglecting intermediate types, and features possessed in common with plants, we may now state the broad characteristics of the Animal Kingdom, recognizing that, especially amongst the lower and degenerate forms, exceptional features occur. Animals utilize for the purposes of living, more or less solid food, which they assimilate in a soluble form. They obtain the necessary carbon from complex organic compounds – carbohydrates, fats, &c., which are in the first instance built up by green plants; their nitrogen is derived from nitrogenous compounds not simpler than proteids, made by other organisms. Most of them are known to get rid of nitrogenous waste products. They rarely possess chlorophyll, such as is distinctive of green plants. Their component cells often have no very definite cell walls, and such as they are they are not markedly different from the cell substance. There is generally marked division of labour amongst the cells of the animal body, resulting in well-defined systems (nervous, locomotor, &c.) allotted to the performance of the different animal functions (see ANIMALS, FUNCTIONS OF). The fundamental distinction between true animals and plants is that animals utilize food material elaborated by green plants; they convert this potential energy into kinetic energy in locomotion and external work. They are characteristically oxidizers, and are predominantly active.

An outline of the various broad divisions of the animal kingdom may now be given. It is convenient to maintain the old distinction of VERTEBRATE or backboned animals, and INVERTEBRATE, although various intermediate types exist. Commencing with the former we have at the top of the scale the most highly organized animals, the group in which man viewed from the zoological standpoint must be placed, *i.e.* the MAMMALIA. This includes such animals as monkeys, bats, hedgehogs, moles, horses, cattle, cats, seals, whales, rats, kangaroos, &c. Diverse as these may appear to be, they all possess in common important characters which separate them from all other kinds of animals. They are all in infancy suckled with mother's milk, they possess hair upon their bodies, they are warm-blooded, there are generally convolutions on the front part of the brain, and before birth they are very closely united to the mother by a complex structure called the placenta. Most mammals are terrestrial, but various types, such as seals, whales, and seacows, have taken to the water, and bats have become adapted to aerial life.

There is no doubt as to the class which must be ranked next to the mammals. BIRDS, although along different lines, must be regarded as being developed quite as highly as most mammals. They possess a covering of feathers in place of hair, and the temperature of their bodies is on the whole distinctly higher. Their fore limbs are modified to serve as organs of flight; even flightless birds have at least vestiges of wings. In their skeleton there are many adaptations for flight, the bones are frequently spongy or hollow, and there is considerable fusion of bones in various parts. Modern birds have no teeth. Doubtless the most important distinction between birds and mammals is found in their relation to their offspring. Yet although birds are oviparous, there is on the whole much parental care exhibited. By far the majority belong to the Carinatæ or flying birds, characterized by the possession of a keel or carina upon the breast bone, to which the muscles of flight are attached; there is a small minority of running birds (ostriches, emu, cassowary, kiwi), with wings incapable of flight and with no keel (Ratitæ); and there is an extinct bird, *Archæopteryx*, which exhibits various reptilian characteristics. It is the study of extinct mammals and birds which reveals between these two classes closer relationships to the reptiles than to each other.

REPTILES do not form such a coherent group as do the higher types. Of living representatives we recognize crocodiles, the remarkable *Hatteria*, or New Zealand lizard, true lizards, snakes, and tortoises. But the group was in the past Mesozoic age much more prolific of types, witness the gigantic extinct saurians, than the class is to-day. The reptiles of the present time are cold-blooded animals, with scaly exterior; they resemble birds and mammals in having during embryonic life two important fœtal membranes, the amnion and allantois; they differ from the next group in never at any stage of their life-history possessing gills.

AMPHIBIANS, the frogs and toads, newts and salamanders, mark the transition from aquatic to terrestrial life. Whilst almost all amphibians have gills, in their larval stages at least, they all in the adult condition possess lungs. But in addition to possessing lungs, their limbs are digitate and of the same type throughout as those of the three higher classes. In larval life, however, many are characteristically fish-like.

FISHES are a prolific race, well represented in numbers and in species. They are markedly adapted to aquatic life. They are cold-blooded, their respiratory organs are gills, borne upon arches at the sides of the head, their limbs are non-digitate fins and serve for steering and balancing rather than propulsion, which is effected chiefly by the tail. Typically they have a scaly exterior, and have numerous glands and sensory structures upon the body. The 'lateral line' of bony fishes is such a structure. True fishes possess a heart of two chambers only, which drives impure blood to the gills; but there exist forms known as the Dipnoi or mud-fishes, which have a rudimentary three-chambered heart, nostrils opening into the mouth, and a lung. They are functionally transitional between fishes and amphibians, but they are probably not directly genetically related. Apart from the Dipnoi there are three great orders of fishes: the sharks and rays with gristly skeletons,—the Elasmobranchs; the sturgeons, bony pike of America, &c., known as Ganoids; and the Teleosteans or bony fishes, *e.g.* cod, herring, salmon, &c.

The foregoing groups—mammals, birds, reptiles, amphibians, and fishes — constitute the Vertebrata or back-boned animals; but before passing on to consider the Invertebrata, it falls to us to mention the existence of several types which in their structure or development serve to bridge over the gap between these two divisions. The CYCLOSTOMATA, represented by the lamprey and hag, and a few other forms, are distinctly vertebrate in their plan of structure, although their skeletal axis consists of an unconstricted cartilaginous rod—the notochord, which is the precursor of the true backbone in all vertebrates. They are further devoid of jaws, another feature which distinguishes the other types from fishes upwards; and they have still other peculiarities. Simpler than these are the lancelets or CEPHALOCHORDA, small fish-like creatures, pointed at both ends, occurring generally in shallow water amongst sand. These have an unsegmented notochord and a dorsal nervous system, but are without jaws, skull, brain, heart, limbs, &c. The Tunicates or UROCHORDA, better known as seasquirts, the majority of which are degenerate in adult life, are undoubtedly vertebrate in their affinities. In their larval stage and in the adults of non-degenerate forms, there is a notochord in the tail region, a dorsal nervous system, gill slits, and a simple ventral heart. More doubtfully there are placed here *Balanoglossus* (a worm-like creature with gill slits, a so-called notochord in the anterior region, and with nervous system in part dorsal) and some other forms, classed together as Hemichorda or ENTEROPNEUSTA.

Before passing on to consider invertebrates, it seems advisable at this stage to summarize the more important features which distinguish the sub-kingdom just reviewed. As already indicated, the clear-cut distinction which characterized earlier classifications no longer exists. It will be noted that the transition is marked by a series of forms possessing amongst other features a dorsal supporting axis or notochord. The great interest and importance of this fact lies here, viz. that this structure occurs in all true vertebrates as a transitory embryonic organ which is subsequently replaced by the backbone. It is thus a structure of phyletic significance, and it is usual, therefore, in strict zoological classification to speak of chordate and non-chordate animals—CHORDATA and NON-CHORDATA rather than Vertebrata and Invertebrata. It will have been noted that all the so-called primitive vertebrates have a claim to rank as chordate animals. Correlated with the possession of a notochord, we find clearly developed in the true vertebrates the following. The central nervous system, that is, the brain and spinal cord, is tubular and occupies a position dorsal to the notochord itself. The essential parts of the eye—retina, optic nerve—are formed by an outgrowth from the brain. Gill slits or visceral clefts open from the sides of the pharynx to the exterior; in fishes, and at least young amphibians, they are associated with gills, and are thus functional in respiration; in higher forms they are known only in the embryo, are transitory and functionless except when modified into other structures. The heart of vertebrates is situated towards the ventral region of the body.

Passing now to the invertebrates or nonchordates, we find it is not possible with the same certainty to group the various classes in a phyletic series. Although the groups themselves are well-defined, affinities between these are, except in some cases, far from clear. It is usual to place at the top of the series, the forms known as MOLLUSCA. These constitute a rather diverse group both as regards structure and habits. They are the Bivalves, such as oyster, mussel, &c.; Gasteropods, *e.g.* the snails and slugs; Cephalopods or cuttlefish; *Dentalium* or tooth shells; and the Amphineura, primitive forms. Most of these possess a concentrated type of nervous system, consisting of at least three pairs of ganglia. They possess a muscular protrusion upon the ventral surface, termed the 'foot', which serves in the majority as an organ of locomotion. In most cases a single or double fold of skin, called the 'mantle', secretes a protective shell. Though not possessed by all, a chitinous toothed ribbon termed the 'radula', used for rasping the food, is characteristic of the group. There are two common larval stages, the trochosphere and veliger. In general, molluscs are sluggish animals. Their relationships are uncertain; most probably they are derived from the ancestral types which gave rise to the unsegmented worms.

An important series is that of the ARTHROPODA or jointed-limbed invertebrates. It includes the Crustacea, which are for the most part aquatic, breathing by gills or through the skin. They are the crabs, lobsters, water fleas, fish lice, &c. They have a hard outer crust of carbonate of lime, and carry two pairs of feelers upon the head. Most crustacea are carnivorous and predatory, some feed on dead creatures and organic debris in the water, a few feed on plants, and there are numerous parasites, and some commensals, *e.g.* hermit crab and sea anemone. Pelagic minute forms (Entomostraca) occur in enormous numbers, and form an important element in the food supply of fishes. The class Myriapoda, another division of the Arthropods, comprises the centipedes and millipedes. The former, which have a pair of legs to each segment of the body, are both carnivorous and poisonous; the latter, with two pairs of legs to each segment, are vegetarian, and harmless to animals. The Insecta, another division, comprising more species than there are of all other animals combined, are an important group of diverse habits, having many and complex relations with other forms of life and of human activity. They are structurally similar to the Myriapoda, but exhibit concentration and grouping of the body segments, have fewer and more specialized appendages, and many possess wings. On the whole, also, their instincts are more varied and specialized. Here should be mentioned the Prototracheata, a group created for the reception of several genera, of which *Peripatus* is the commonest. This is a small, terrestrial, worm-like creature having a remarkable distribution, occurring in South Africa, Australia, New Zealand, West Indies, South America, &c. It is of interest not only in that it is undoubtedly an animal of very great antiquity, but that it is a transitional form between insect-like arthropods on the one hand, and segmented worms on the other. The group of spiders, scorpions, mites, and ticks known as the Arachnoidea form another section of the Arthropod phylum; they are neither a very coherent group, nor are their immediate affinities very certain. They exhibit greater concentration of the body regions than insects, and, apart from their tracheal breathing apparatus, resemble them but slightly. Several aberrant orders, probably related to these, can be but mentioned, viz., the Tardigrada or Water Bears, microscopic creatures to be found in dust, amongst moss, &c.; the Kingcrabs or Xiphosura of the shores of North America and various waters of the far East; the fossil Eurypterids and Trilobites; and the Pycnogonids or sea-spiders. Very diverse in form and habit as the various types of this important phylum are, the group as a whole is remarkably well-defined and marked out from other phyla by the possession of amongst others the following characters. The skin is strengthened by a cuticle of chitin, the body carries a series of paired appendages which are jointed; it is divided into segments, and the symmetry is bilateral. The nervous system consists of a brain situated above the gullet, a nerve ring around the latter, connecting the brain with a double chain of ganglia which passes along the ventral surface. Economically the group is of considerable importance (see references in this work to various insects, ticks, &c.).

Possessing fundamentally the same plan of structure, and very probably related, are the ANNELIDA or ringed worms; in symmetry, segmentation, and type of nervous system, the two phyla are alike. An important structural feature also in the Annelida is the body cavity or cœlome, the space between the body wall and the gut, which arises as a cavity in the mesoderm or middle germinal layer. Beginning amongst lower types, it is first clearly seen in the Annelids. The group embraces several types of diverse habits and structure. As examples of the bristle-footed worms or Chætopoda may be quoted the familiar earthworm and the fisherman's lobworm. These may be regarded as typical, but there are various divergent, parasitic and primitive forms. The leeches or Discophora are probably Annelids which have become modified in consequence of their semi-parasitic habits. More or less closely related to Annelids may be named the ROTIFERA, whose adult form somewhat resembles the trochosphere larvæ of many Annelids, more distantly the Polyzoa, *e.g.* the seamat, and Brachiopoda or lampshells.

The ECHINODERMA constitute a well-defined series. They are the starfishes, brittlestars, featherstars or sea-lilies, sea-urchins and sea-cucumbers. They exhibit radial symmetry in the adult condition, but that of the larva is bilateral. A characteristic structure is the water vascular apparatus, a system of vessels containing a watery fluid subservient to locomotor and respiratory purposes. There is a marked tendency towards the deposition of lime in the tissues. Their development is 'indirect', the adult developing as a new growth upon the tissues of the larva. Most members of the group practise selfmutilation or 'autotomy' in unfavourable circumstances, *e.g.* the yielding up of the arms by many starfish on capture. This practice is associated with the power of regenerating the lost parts. The Echinoderma are all marine.

In addition to the Annelids already referred to, there falls to be mentioned a somewhat varied and heterogeneous collection of 'worms'. They agree with the Annelids in possessing bilateral symmetry, but they have no appendages and are unsegmented. Of these the most important are the NEMATODA or threadworms and allied forms, many of whom are parasitic in plants or in animals; also the FLATWORMS, embracing the free-living Turbellaria, the parasitic Flukes or Trematoda, an example of which is the important parasite the liver-fluke of the sheep (*Distomum hepaticum*), and the Tapeworms or Cestoda. Here also are placed the marine Ribbonworms or NEMERTEA. At this point we have reached in our descent of the animal scale another stage in the developmental history of animals. The feature of bilateral symmetry, the possession of a body cavity, the presence of three embryonic layers (ectoderm, mesoderm, and endoderm), are distinctive characteristics in a more or less clearly defined degree of all the foregoing animal types. It is useful to separate these as Cœlomata from the types which follow.

The remaining multicellular animals, CŒLENTERATA and PORIFERA, are more simply organized. These have no body cavity, the only internal cavity is that of the food canal. The radial symmetry of the embryo persists in the adult, and there is no definite middle cellular layer (mesoderm), but only in some a middle jelly (mesoglœa). Cœlenterata are zoophytes, jellyfishes, sea anemones, corals. They are mostly marine. The body may be a tubular polyp or a bell-like 'medusoid'; in some there is an alternation of generations between the two types. Asexual multiplication takes place by budding and fission; in the latter case many have limy skeletons which form corals. The Porifera or sponges are the simplest many-celled animals, but their simplicity is generally disguised by budding, folding, &c., and by the presence of supporting skeletal parts of a horny, limy, or siliceous nature. This concludes our survey of the multicellular animals, the Metazoa. We have now reached another important stage, the transition from the Protozoa, animals which within the compass of a single cell perform all the necessary functions of life, to the Metazoa, which, dividing the labours of the body, have distributed the various functions amongst various groups of cells more or less appropriately specialized.

The **Protozoa** are the simplest of animals, and are usually only single cells. Even when they form colonies of cells, each cell is functionally similar to its neighbours; there is no differentiation (except in a few cases for reproductive purposes) of parts comparable to the Metazoan 'body'. They are almost exclusively microscopic, very diverse in the form of their cell, many of which, *e.g.* the Infusoria, exhibit much specialization of parts. Many, again, have a skeletal framework of lime, flint, or other substance. In some cases these 'skeletons' form extensive deposits, *e.g.* the chalk-forming Foraminifera or the Radiolarian 'Barbados earth'. An entire group, the Sporozoa, is parasitic, and of considerable importance to man on this account. The life-histories of the Protozoa are very diverse, and in some, especially the parasitic forms, extraordinarily complex, involving more than one host. The Protozoa are further of interest and importance for the light they throw upon the beginnings of life itself. They merge by imperceptible transition into those Protista which link them to the lowest plants, and which themselves are the lowliest of known organic forms.

OUTLINE OF ANIMAL CLASSIFICATION

BACKBONED ANIMALS: Technically *Vertebrates* or *Chordata*

I. *With Skulls and with Jaws*

MAMMALS	Man, Anthropoid Apes, Monkeys, Lemurs. Carnivores, such as cats, dogs, bears, and seals; with Insectivores, such as hedgehogs and moles; and the divergent Bats;—as related orders. Ungulates, such as pigs, hippopotamus, cattle, sheep, deer, camels, &c.; horses, rhinoceros, tapir; elephants; hyraxes; with Rodents, such as rabbit, squirrel, mouse, and porcupine; and the divergent Cetaceans, such as right whale and dolphin. Primitive orders—Sirenians, *e.g.* dugong and manatee; Edentates, *e.g.* sloths and armadillos. On a lower grade, the Marsupials, *e.g.* kangaroo and bandicoot. On a still lower grade, the oviparous Monotremes—duckmole and spiny ant-eater.
BIRDS...............	Keeled flying birds, *e.g.* Eagle. Keelless running birds, *e.g.* Ostrich. Extinct reptile-like bird—*Archæopteryx*.
REPTILES	Crocodiles and Alligators. Snakes. Lizards. Tortoises and Turtles.
AMPHIBIANS	Tailless Frogs and Toads. Tailed Newts. Labyrinthodonts and other extinct Amphibians.
FISHES	Double breathers—Mudfishes. Teleostomes (Teleosteans and Ganoids), *e.g.* Salmon, Sturgeon. Elasmobranchs. Cartilaginous fishes.

II. *With Skulls and without Jaws*

CYCLOSTOMES ...	Hagfish and Lamprey (*Round Mouths*).

III. *Without Skulls*

Amphioxus and other lancelets; Tunicates or Sea-squirts; *Balanoglossus*, *Cephalodiscus*, and other *doubtful* intermediate forms between Vertebrates and Invertebrates.

BACKBONELESS ANIMALS: Technically *Invertebrates* or *Non-chordata*

MOLLUSCS	Cuttlefishes. Snails. Bivalves, &c.	
ARTHROPODS......	Spiders, Scorpions, Mites, Ticks. Insects. Centipedes and Millipedes. *Peripatus*. Crustaceans. Kingcrabs.	
ECHINODERMS ...	Feather-stars (Cystoids and Blastoids, extinct). Brittlestars. Starfishes. Sea-urchins. Sea-cucumbers.	
'WORMS'	Bristleworms. Leeches.	Annelids or Annulates.
	Lampshells or Brachiopods. Polyzoa, *e.g.* Seamat. Threadworms. Ribbonworms.	
	Tapeworms. Flukes. Planarians.	'Flatworms'.

The foregoing are sometimes grouped as Cœlomata.

CŒLENTERATES ..	Jellyfishes and Sea-anemones. Zoophytes and Medusoids.	*Acœlomata.*
PORIFERA	Sponges.	
PROTOZOA	Simplest forms of animal life.	

[J. R.]

Animal Labour.—The animal labour employed on the farm includes that of man, the horse, the ass, the mule, and the ox. In some countries the dog is also employed in subsidiary labours associated with the practice of agriculture, and its employment by the Eskimo for purposes of draught is universally known. In Britain, however, the dog is solely employed as a hunter, as a watch, and as a companion, and never as a labourer on the farm. Apart from man himself, the horse is the chief animal power employed on the farms of the United Kingdom. In Scotland hardly any other animal is kept on farms for purposes of draught; but in England oxen are still used in farm labour to a limited extent; while on the smaller farms of Wales and Ireland, as well as in the market gardens round London, the ass forms a valuable working assistant on the farm, and is in regular use as a carrier of farm and garden produce, and for other similar purposes. No feature of farming in the west of Ireland is more characteristic than the farmer's wife taking eggs and butter to market in her little donkey-cart.

At no very ancient date, however, oxen were the chief animals employed in Britain in the tillage of farms, and over a great part of the continent of Europe they have been used from time immemorial, and are still employed in large numbers for this purpose. Their gradual displacement in Britain in favour of the horse appears to have been brought about through the operation of a variety of causes, chief of which were the development of a more complex system of husbandry, and the opening up of wider connections between the producers and consumers of agricultural produce. In days when each farm was in great measure selfcontained, when every farmer and his family lived on the produce of his own holding, when there was no purchase of manures, little sale of crops and of stock, and no communication with distant markets, when tillage itself was of a very primitive character, and the practices of thorough cultivation, which date from the introduction of the drill system of husbandry, were unknown, ox teams were regarded as quite capable of doing all the work of the farm. But with the improvement of cultivation that set in after the introduction of the practice of green cropping, with an increasing town population to which farm produce began to be sent from long distances, with the opening out of roads and the increase of intercourse between farms and markets, and a greater interchange of products, the advantages of horse labour began to be felt, and the use of oxen on the farm steadily diminished. Changes in the character of the horses themselves also began to be made, leading to their improvement for draught purposes. Nevertheless, even at so late a date as the first half of the 19th century, the relative advantages of oxen and horses for use on the farm continued to be keenly discussed, though at that time they had been almost entirely discarded in Scotland and also generally in Ireland.

The advantages claimed for oxen were that they were steadier workers in such heavy tillage as ploughing, that they required less capital to purchase, and were less liable to accident and disease, that they increased in value every year instead of depreciating heavily as horses generally do, and that they cost less for food, shoeing, harness, and attendance. All these advantages, it may be noted, sum themselves up in the one word economy. So far as concerns efficiency of labour, practically no claim was set up for them.

In favour of horses it was pointed out that they were much more active and expeditious workers, that they were more intelligent and adaptable, that they threw more energy into their work, and were ready if necessary to undergo prolonged fatigue and to make special exertions; while the ox, on the other hand, while willing to work steadily at one dead level of effort, refused or succumbed on the occurrence of any special strain. It was not successfully denied that horse labour was more costly, but it was held that its greater efficiency more than compensated for the greater expense, and that the more expensive labour would also prove to be the more profitable.

Time and experience proved themselves to be on the side of the horse, under the conditions of agriculture prevalent in Britain during the 19th century. First in Scotland, and gradually further southwards, the use of oxen in the cultivation of farms was given up, and they are now only employed for such purposes in a limited degree in some parts of the southern counties of England. But on the continent of Europe they are still extensively maintained on farms as the chief animals of draught, while in Cape Colony, and in many other parts of the globe into which railways have not penetrated, the ox wagon still remains the chief means of transport. In France they are especially numerous in the districts of small farms, as in Saintonge and Poitou, and in the Limousin, and it is stoutly maintained that in the existing circumstances of agriculture in these provinces no other labour could be so profitable. One of the chief factors which seems to throw the balance of advantage in certain provinces on the side of the ox, is the small size of the holdings existing in them. On small farms the amount of capital required for the purchase of horses and the risks of total loss involved are greater than can be safely borne by men of small means, while on holdings below a certain size, full employment cannot be provided for a pair of horses, and the amount of produce they consume detracts seriously from the sales and income of the holding. On behalf of the ox it is affirmed that if employed in moderate work only, he is healthier, has a better appetite, and fattens almost as rapidly as when kept in confinement, and that his work is got at little or no cost. It is also claimed that the beef of a bullock that has been kept at moderate work is of better quality and richer flavour than that of an animal kept without exercise during the fattening period. To obtain the most satisfactory results it is essential that the animal should be fed up to the maximum that he will eat with suitable foods, and that care should be taken not to overwork him. His employment in work for one day in four, or for about ninety days in the year, is regarded as the proper amount. In the valleys of the Pyrenees, cows are regularly employed for draught purposes as well as oxen. They at the same time suckle their calves, and yield milk in addition for the use of the farmer.

Another factor that in great measure determines the choice between the horse and the ox for farm labour is that of climate and temperature. In a cold and stormy country like Scotland and the north of England, field labour is pushed on at greater speed; men work with more energy and activity, and require the animals assisting them to move at a similar pace. The quick-stepping Clydesdale suits their pace better, either in the furrow or on the road, than the slow-moving bullock. But in the hot and oppressive summer days that occur in abundance in more genial climes, quick action and rapid work are not possible. Slow-going

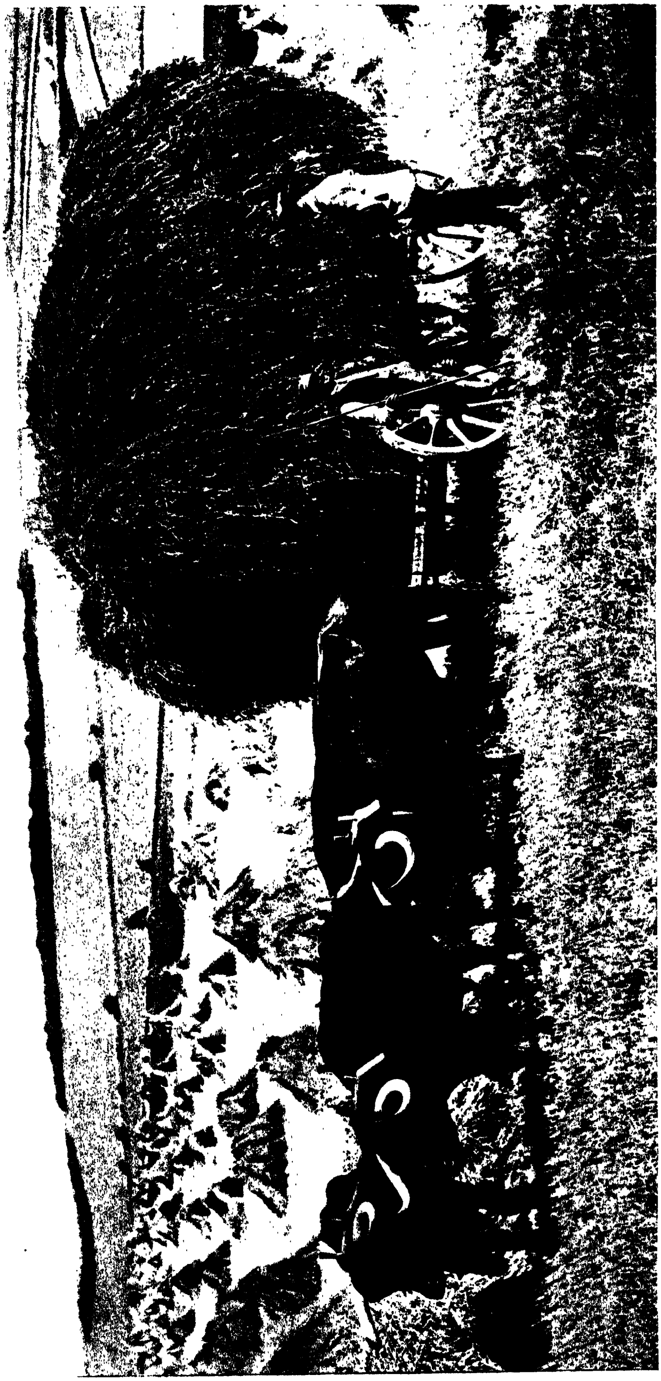


Photo. Thos. Fall.

SUSSEX DRAUGHT OXEN IN THE HARVEST FIELD steady exertion is all that can be got either from beast or man. For such work the ox is admirably suited, and under such conditions it does not seem probable that it will be displaced by the horse. As to the breeds of cattle most suitable for draught purposes, it is obvious that active, hardy cattle, provided they are of docile disposition and easily manageable, are better adapted for labour than the heavier and softer breeds that have perhaps greater fattening aptitude. Of the various British breeds, the Devon and the Sussex have been most used for purposes of draught, and to a less degree the larger and heavier Hereford. All these breeds possess frames well adapted for traction, as they are strongly and massively developed in the shoulders and chest, while they have quiet and placid tempers which make them easy to break and handle. The Sussex ox makes a strong and steady worker, capable of moving a good weight, while the Devon, though less in size and strength, possesses greater activity, and is superior in symmetry and perhaps also in intelligence and docility. See also arts. on Ass, Ox, MULE, HORSE POWER, MOTIVE POWER. [R. P. W.]

Animal Nutrition. See NUTRITION.

Animal Parasites. — Animal parasites are animals which at some stage of their life-history derive both protection and nourishment by living in or upon the body of another organism—plant or animal—generally to its disadvantage. The number of different kinds of parasites is large; most groups of the animal kingdom afford examples, and some groups are entirely parasitic. Such are the Sporozoa, the Trematoda or Flukes, the Cestoda or Tapeworms, and the Acanthocephala or hook-headed worms. Nematoda or threadworms, and Copepoda belonging to the Crustacea, are largely parasitic. It will be noted that these forms are exclusively Invertebrates; parasitism amongst Vertebrates is happily almost unknown. The best-known case is that of the hagfish, which inhabits the body of the cod. The Vertebrata more commonly serve as hosts.

Parasitism exists in very various degrees. There are external or ecto-parasites, which live upon the outside of their host, extracting nourishment from its body. These may move about freely upon it, such as fleas and lice, or they may remain more or less fixed in one place, *e.g.* Copepoda ('fishlice'), ticks, and some flukes. Endo-parasites inhabit the internal cavities or organs of the body; these are the more numerous, and of greater importance. The alimentary canal and associated organs, being in direct communication with the exterior, are most frequently infected. Here we find Protozoa, Liver Flukes, Tapeworms, Threadworms, larval bot-flies, &c. Recent researches have shown that the blood may harbour microscopic animal forms, *e.g.* malaria parasite, trypanosoma, piroplasma, &c., many of which are the cause of important animal diseases, reference to which will be found under their respective heads. Regarding special structures in parasites, only very general facts can here be stated. There is a general tendency towards the loss of sensory and locomotor organs, especially in the stationary forms. Organs of fixation are common, such as hooks and suckers, *e.g.* in Tapeworms and Flukes. The life-histories are frequently complicated, involving more than one host, and free-living stages may intervene. A familiar example is that of the liver fluke, which has two or more larval generations in the pond snail, followed by a free-living cercaria stage in moisture upon the grass. On being swallowed by a sheep the cercaria develops in the liver and bileducts into the adult sexual fluke. The difficulties amongst parasites in the way of finding a fresh host for each successive generation are very great, and to meet these, enormous numbers of eggs are generally produced. Each segment of a tapeworm may produce half a million or more eggs, and there are usually numerous segments.

Parasites may secure the needed protection and nourishment without inconvenience or injury to the host, and this appears to be the case in some instances at least. Many fish harbour large numbers of Cestodes in the intestine and yet appear perfectly healthy. There are, however, many possibilities of injury. Larger parasites, especially if numerous, may cause blocking of intestinal or other passages; there may be mechanical injury due to pressure on delicate organs. Further, in the case of young animals especially, the loss of nutritive material may be serious. At the point of fixation or of burrowing, the injured tissue may become the centre of secondary infection by bacteria or protozoa. Then parasites which migrate from one region to another not only do injury by the way, but they may reach organs where their presence causes serious or even fatal results, *e.g.* hydatid cysts of tapeworms. Then it appears to be established that many parasites excrete toxic substances which evoke serious disorders of a nervous nature. Lastly, there should be recalled the various trypanosomiases and piroplasmoses—definite diseases caused by the presence of protozoal organisms in the blood of various vertebrates. See ASCARIS, CESTODA, STRONGYLUS, &c. &c. [J. R.]

Animal Products and their Uses.— A list of the above could be composed such as would strike the honest vegetarian with amazement, and make him pause to consider how the world's needs might be supplied if converts to his views were made in any considerable number.

It may be said that no part of an animal is wasted under modern conditions and where slaughter is carried out in proper abattoirs, where facilities exist for the disposal of what was formerly termed the 'fifth quarter'. The hair and skin, the hoofs and horns, the bones, the blood and fat, and even the refuse of these, provide useful commercial commodities in ever-increasing ratio as the discoveries of science advance. Commencing from the outside, we may refer to the hirsute coverings of animals, known as bristles and hairs. The difference is not so much in anatomical arrangement or histological character as in stoutness, in length, and strength. Bristles are most developed upon swine, although coarse hairs called by the same name are found upon certain parts of horses, as along the under jaw during the cold season, and along the spine of dogs — notably those hairs which are erected as a sign of anger or excitement. The so-called 'feather' upon the legs of Shire horses compares with the bristles of swine, except in the more refined families, where a softness resembling that of the Clydesdale has been cultivated by careful breeding. A breed of pigs is reared in Russia specially for the strong bristles which grow along the spine, and are of the highest value to bootmakers; a second quality entering into the best of hair-brushes. For the coarser work of painters, bristles of various kinds are employed, but for artists' pencils those of the camel, sable, badger, and polecat are used. Hair that is unfitted for spinning into yarn, while of soft texture, as that of the rabbit, hare, cat, and rat, is utilized for the making of the better class of felt hats, and in this department the French excel. For roofing felts and such as are employed in covering boilers and steam pipes, the hair of bullocks is used, and the least clean and valuable samples are worked up in mortar as a binding material for house-building. The tail and mane hairs of horses and cattle lend dignity to our law courts by entering into the composition of official wigs, and give comfort to our bodies when used to stuff cushions and articles of furniture. The whole of our space would be taken, if we attempted to describe the many uses to which the hair and bristles of animals are devoted—in making crinoline for ladies' bonnets, and fishing lines for the angler. Enough has perhaps been said to indicate the great value of the external covering of animals.

The tanner divides into two classes the skins of animals primarily, denoting all small ones, as those of the calf, sheep, and goat, as 'skins', and those of the horse and ox and large animals as 'hides'. These latter only are obtainable in quantities that can be readily dealt with by commercial methods, as hides for tanning into leather. The manufacture of calf skins and those of sheep fall into another category, and are esteemed for special purposes. The ox and horse afford the most valuable and useful hides, and the supply is constant in Europe, as a result of slaughter for food or other reasons; while in South America, Australia, and some parts of Africa the hide is the most valued portion of the animal. Britain is the country of import for vast numbers of hides and skins from all parts of the world, and the leather trade one of much importance. Skins of intermediate substance—between the ox and horse hide and those of calves and sheep—come from India, and are known as kips. On account of their great number, the skins of sheep and lambs render them of only secondary importance as market products to those of the stouter hides of the larger animals. The tanning of hides has of recent years undergone a complete revolution. The tanner's pits of oak bark are only to be seen in a few country districts, and no longer pay, despite the preference given to leather made in the oldfashioned way and occupying months in preparation. Practically the same results are now obtained by chemical processes extending over a much shorter period.

A very important use for sheepskins and some of the finer calves and goats is that of parchment, the making of which is one of the oldest industries of the world. Having regard to the documentary evidence of ages, preserved on parchment or vellum, the indebtedness of civilization to this animal product is inestimable. The industry is in a very few hands, and may be described almost as an hereditary calling: son succeeding father over a period of centuries, and acquiring a degree of skill unchallenged by outsiders, who are not tempted to compete for a market so limited. The wool or hair is first removed, and the skin stretched upon a herse. The fleshy panicle and superfluous fat is removed by a semicircular knife, and some of the moisture expressed in the process. Inferior skins are allowed to dry after this, and are suitable for drum heads and binders' purposes; but the finest selected skins undergo further preparation with chalk and pumice stone on the flesh side, until a fine velvety surface is obtained. The stoutest vellum is made from calfskins, and the thinner and cheaper varieties from split sheepskins. The trimmings are boiled down for making glue and dubbin, so that nothing is lost.

Glue is an impure variety of gelatine, and is obtained from skin, bones, horns, hoofs, intestines, and tendons of animals, and bladders of fish—the finest from the sound of the sturgeon, and the coarsest from the hoofs of horses. Chondrin is procured from cartilaginous substances, and differs only in purity from other forms of gelatine. That prepared as a culinary article from calves' feet, and recognized as calves'-foot jelly, is one of the purer kinds of gelatine. Glue makers utilize the refuse of the tanner and the parchment maker: the cuttings or parings of hides, sheepskins, the ears of bullocks and sheep, rabbits, hares, cats, dogs, and even old gloves, may be added to the cauldron; hence the many grades of glue, dependent, of course, upon the quality and proportion of pure gelatine to extraneous matter.

Gelatine prepared from the finer sources, referred to in the above paragraph, enters into many articles of commerce and domestic utility. The stockpot of the cook is enriched by the gelatine from bones. The paper maker uses it as a sizing agent. By treatment with bichromate of potash a chemical change in its composition is effected by which it is rendered insoluble in water and non-absorbent of it. This discovery has led to its extensive use in photography and other arts. In this altered condition it is employed as a waterproofing material.

The so-called catgut employed for violin, harp, and other stringed instruments; for surgeons' sutures, clock weights, and wherever toughness, durability, and strength are needed with flexibility, is made from the intestines of sheep. They are washed clean, steeped in water; their external membrane scraped off; then macerated in an alkaline bath, rendered smooth and of equal substance by drawing out, bleached by the fumes of sulphurous acid, and then sorted, twisted together or dyed in various colours, according to their intended use. The intestines of animals are utilized as sausage or polony skins, and in many ways as waterproof coverings after special treatment.

The fourth stomach of the calf (abomasum) is made use of to prepare rennet, and is employed in cheesemaking in preference to any other substance, although various acids and ferments have been tried, such as decoctions of thistle tops, artichoke flowers, and butterwort. Dr. Voelcker, the great chemist, holds the view that the specific action it has of converting sugar of milk into lactic acid is *sui generis*, and only known by its action. It is prepared by slicing the membrane into thin strips, salting, and smoking. Spices and aromatic drugs are sometimes added to it, its natural odour being rather unattractive. See RENNET.

The uses of horn in the arts and crafts are numerous, but the earliest record of its manufacture into buttons only goes back to 1777; indeed buttons of any kind were unknown before the reign of Elizabeth, and at that time no holes were made for them; their purpose being purely ornamental, and their distribution being arranged entirely for effect. Horn handles to knives and other instruments, horn rings, discs as non-conductors, horns as musical instruments, and as drinking cups and drenching horns, are everywhere to be found, although being rapidly displaced by materials of other kinds; notably those hardened gelatines mentioned in connection with glue and gelatine in another article.

The chief uses of horns are the same as of hoofs, namely, the manufacture of different grades of gelatine or glue; of waterproofing substances, and hard but light materials produced by so-called carbon processes.

Hoofs are of the same composition as horn, the degree of hardness differing according to the proportion of water chiefly, but in the proportion of gelatine in various parts of the same hoof; the softer frog of the horse, or coronal portion of the ox and sheep, having a larger proportion of gelatine and more water than the plantar surface. Hoofs generally may be said to be less closely constructed than mature horns, and more absorbent when macerated in water. Histologically examined, the hoof presents canals, and the epithelial elements not so closely packed as in horns. Hoofs are therefore less suited for manufacture into buttons and other solid articles than horn, and are generally utilized by the wet processes mentioned in the manufacture of gelatine and glue, or converted into animal oils. Of these, neat's-foot oil is a valuable commodity, and much prized by machinists, watchmakers, and toolmakers. Genuine neat's-foot oil is prepared by boiling the split feet of oxen in an open vessel, or by superheated steam in a closed cylinder. The oil rises to the surface of the decoction and is skimmed off. Inferior grades contain much of the fat, which separates and falls to the bottom of the vessel. The animal oil obtained from the feet of horses is much inferior, as is that of the sheep, but is largely used to adulterate the genuine neat's-foot oil, which always commands a good price. A spurious imitation is made by mixing liquid hydrate of potash with linseed oil, the compound having much the same appearance.

When deprived of fat and gelatine by manufacturers, bones are very largely used for the manufacture of fertilizing manures. (See BONE MANURES.) Blood is maufactured into a manure which contains a high percentage of nitrogen. (See BLOOD MANURE.) The supra-renal and other glands are now employed as animal medicine in the treatment of disease. Fat is used in soapmaking. Glycerine is a valuable byproduct of the soapboiler.

The system of scalding pigs, or of converting to bacon with the skin intact, leaves very little in the form of offal but the intestines for sausage skins and the blood for manure. The pigs' skins used for saddles and other purposes are chiefly obtained from Servia, where hogs are maintained in a semiwild state in the forests. See arts. CARCASS and OFFAL.

[H. L.]

Animals, Diseases of.—The history of animal plagues and the welfare of the peoples of the world are intimately associated. The herdsman is the first step in civilization, long before agriculture, in its original sense, finds a place. It follows, therefore, that animal plagues and the diseases generally of live stock under domestication are of first-rate importance to the health and wealth of a nation. So much may be said of all nations, but of none more emphatically than of the British, whose people have shown an aptitude for breeding, rearing, and management of all kinds of animals, never before equalled in the history of the world. Nor can there be any doubt of the superiority of modern breeds of animals over any that have gone before, whether in comparatively recent or very remote periods. At a time when the Romans described the inhabitants of this country as barbaric, they also clearly show that these inhabitants had made no small progress in agriculture.

Animal plagues have been described, with more or less accuracy, from the time when men first began to record their observations. The late Dr. Fleming, chief veterinary surgeon to the British army, made an exhaustive study of the history of these plagues, commencing from B.C. 1490 to A.D. 1844, since which we have had regular contributions to veterinary literature, and detailed accounts. For the history of animal diseases, then, we refer the reader to Fleming's works. Coming down to our own more immediate times, it is a melancholy fact that ignorance on the part of governments was responsible for the introduction of the most serious plagues ever encountered in this country. Cattle plague was permanent on the Steppes of Russia, and from time to time invaded adjacent countries in the ordinary course of trade distribution of animals, without any official knowledge of the fact. The plague spread westward, and might have been prevented from obtaining a footing in these islands by a very slight expenditure. Ignorance of these matters cost the country millions sterling, and many agriculturists were ruined. Much that was written about animal plagues prior to the 19th century was unreliable and confusing, as the words murrain, plague, distemper, had no very clear meaning, one writer referring to rinderpest and another to anthrax, or pleuropneumonia perhaps; while an element of superstition and some exaggeration made any analysis of such records extremely difficult. By common consent the words cattle plague and rinderpest are now employed only in connection with the specific infectious disease having for its most prominent symptoms 'intense fever, diarrhœa or dysentery, croupous inflammation of the mucous membranes in general, sometimes a cutaneous papular eruption, and great prostration'. Its diagnosis is often difficult, especially at times when its presence is not suspected; hence it follows that the spread of the disease is almost beyond control before the danger is made manifest. Where it is enzootic it takes a modified form, and recovery is the rule rather than the exception, and experts easily able to diagnose the virulent form it assumes in western Europe fail to detect it in Steppe cattle at home. By what is known as the stamping-out system this country has been for many years clear of the disease, although the infection has, at comparatively frequent intervals, travelled westwards to ports having an export trade to these islands. To an efficient system of veterinary inspection, and to more rapid means of obtaining information as to epizootic maladies among animals on the mainland of Europe, we owe our present immunity—an immunity that can by no means be guaranteed when it is remembered that hides are always coming in from all parts of the world, and that no efficient examination of them is possible (see ANTHRAX). The losses in this country in 1865–6 are estimated at 233,629 head, and of a value of five to eight million pounds.

PLEUROPNEUMONIA or lung plague, for destructiveness, stands next to rinderpest. Whether it was really known so long ago as 1693, when Valentine described an epizooty among cattle in Hesse, is doubtful; but what is chiefly remarkable is the spread in some two centuries from a relatively small centre to practically all the cattle countries of the world, a thing that would have been impossible prior to the great intercourse between nations which the era of steam navigation consummated. The outward trade in the best class of cattle from Britain necessarily made her the greatest distributor of the lung plague to other countries. From the earliest reliable information concerning the disease it seems to have been almost confined to southern Germany, Switzerland, France, and northern Italy, a comparatively small area; and it was later spread, like so many other animal plagues, by armies, and the great movements of live stock which their feeding implies. From 1789, when it was more or less limited to the Swiss mountains, it gradually spread, reaching the western ports, from whence it was imported into England in 1841. The insidious manner of its invasion, the subtlety of its *contagium*, and the losses, both by death, and depreciation of the survivors, constitute it one of the most disastrous plagues that can afflict a cattle country. Like rinderpest it is confined to the bovine species.

It is an infectious disease, due to a specific organism, and generally affecting the lungs and their covering membranes and lining of the chest (pleuræ), and producing a nodular or lobar pleuropneumonia. Its localization in the lungs is regarded as proof more or less of infection through the inspired air; but it may be remarked in this connection that glanders, which most frequently is localized in the lungs, has been proved to enter the body by other gates, as by ingestion, inoculation, &c. Inoculation of healthy bovines with the morbid material from the lungs produces characteristic lesions at the seat of inoculation, but does not always result in the lobar pneumonia and pleural trouble typical of accidental infection. With a period of incubation varying from two or three weeks to as many months, no ordinary or practicable quarantine regulations can fence against it, and slaughter of animals affected, as well as those in contact with the diseased, is found to be the only means of dealing with the malady. Although exterminated from these islands, a case or two now and again has been diagnosed, and traced to cattle of foreign origin, or to persons who have had contact with animals slaughtered at the port of debarkation; a cordon has been formed, and stamping-out measures so effectually taken as to prevent the spread of the disease.

FOOT-AND-MOUTH DISEASE, or epizootic aphtha, is believed to have existed in Europe for two thousand years, but Greek and Roman writers leave us rather confused as to this point. That it was prevalent in France, Germany, and Italy in the 17th and 18th centuries there can be no question. It was not until about 1839 that it appeared in England, and was regarded as a new disease. Its spread was very rapid, and the losses occasioned were not so much by death as by reduction of value, loss of profit on dairying, and hindrance to trade in live stock. Sheep and pigs as well as cattle are susceptible, and a mild form of it has been found among men in attendance upon animals affected. The loss to the farmer and stockbreeder, the grazier and butcher, during the continuance of the plague was perhaps as great as that from any of the more fatal diseases. The stamping-out system is adopted with this disease. Bacteriologists are not agreed as to a specific organism, but a micrococcus has been discovered which produces the disease by ingestion but fails by inoculation. The stamping-out method is adopted in this country, and is universally endorsed as the wisest course to pursue.

ANTHRAX.—In one or other of its forms anthrax prevails over the entire surface of the world, affecting wild as well as domesticated animals and man. While perhaps more prevalent in the tropics than the Polar regions, it affects the reindeer of Lapland and the live stock of temperate regions. The injuries it inflicts are incalculable. Marshy lands or those with a stiff impermeable subsoil are the most subject, and there are districts in Europe (France, Germany, Hungary, Poland) where it annually inflicts such severe losses as to have made stock rearing almost impossible to be carried on at a profit, until the system of protective inoculation was introduced. In Siberia, so terrible has been the plague at intervals, that it has been found necessary to employ regiments of soldiers to bury or burn the carcasses of animals lying in swamps or floating in canals and infecting the air and watercourses. It seems tolerably certain that the murrain of Exodus was anthrax, and having regard to the previous visitations of the water of the rivers, the frogs, lice, and flies, the carriers of the disease may be indicated.

So much dreaded was anthrax that classical writers allude to it as *the* murrain, all other disorders seeming to them of comparative insignificance (see Virgil, Georgics, III). As a devastating pestilence among animals, and communicated through them to man, it constantly occurs in the history of the Middle Ages. Many and curious are the recipes to be found in the early Anglo-Saxon writings, for a plague which was and is even still held in remote districts to be due to evil spirits, as the name puck or pook applied to the blackleg form of anthrax indicates.

It was in the investigation of anthrax that the disease-producing bacilli were first discovered—a discovery which has given to medicine and to research a wholly different bent, and led to the great advances in preventive medicine, and promotion of the knowledge of hygiene. Pollender and Brauell, Davaine, Chaveau, and Toussaint prepared the way, and Pasteur carried out a system of cultivating bacteria by which the morbific poison is employed as its own antidote.

The infectious diseases which from time to time spread rapidly and decimate our flocks and herds are not so many in number as in importance. They include a larger number now than when we had less knowledge of pathology, as for instance glanders and farcy, which are now known to have a common origin, the one running into the other. Farcy is an outward manifestation of a disease of chronic form, the lymphatic vessels being chiefly concerned, but it is only a question of time when the acute form, glanders, shall develop. The lungs show the characteristic lesions of glanders when no clinical signs have been discovered. A discharge from one or both nostrils, with ulcers on the membrane within, are the diagnostic symptoms. A preparation of the debris of glanders bacilli, known as mallein, is now employed as a diagnostic agent, and is valuable as enabling horse owners to determine whether an animal is affected with glanders while as yet there are no clinical signs. The disease is due to specific bacillus, which may infect by contact with the respiratory membranes, by ingestion with the food, or by inoculation through a wound or abrasion. Glanders causes the death of human beings every year, and the loss of enough horses to supply the British army with all the remounts required; nevertheless it has been found impossible to induce any government to adopt sufficiently stringent and costly measures to eradicate it.

VARIOLA or cowpox is important chiefly for its relationship to smallpox in man, and the immunity, or comparative immunity, vaccination confers. Other vesicular eruptions, as sheep-pox, occur among the domesticated animals, but seldom take a serious form.

SWINE FEVER is due to an ovoid bacterium and takes a variety of forms; so much so is this the case, that the Board of Agriculture places no confidence in the diagnosis of its own appointed veterinary inspectors, but requires them to send the viscera to the laboratory, for cultures to be made and the specific organism to be identified, before arriving at any decision. The delay is vexatious to owners, and compensation so tardy that the temptation to concealment has too frequently been yielded to, and is doubtless one at least of the reasons why so little progress has been made towards stamping out a disease which continues to inflict great hardship on individuals and financial loss on the community. The manner of infection is still shrouded in mystery. The most careful investigations have failed in so many instances to trace the disease either from swine or mediate bearers. No man or beast, or article of clothing, or goods of any sort from an infected area have been imported into new centres of infection, which are often very wide apart, and the animals been long living in isolation from the rest of the world; yet outbreaks have occurred—nay, constantly occur—under conditions seemingly impossible of infection from the nearest or any known source of the disease. The stamping-out system so often referred to in connection with other animal plagues has so far failed in respect of swine fever, and of swine fever alone. That the regulations as to markets and fairs, and the restriction of movement of swine in infected areas, have served to keep down the disease and hinder its extension cannot be doubted. There is a disposition on the part of those in authority to enforce the rules with increasing strictness.

The awful disease of RABIES has been stamped out in these islands, and no case has occurred for several years, although a number of suspicious ones are reported every year. It is matter for national congratulation that none has proved to be rabies. The muzzling of dogs was very unpopular with a large section of the public, and Mr. Long deserves lasting honour for his courage in facing a storm of indignation from owners of these animals, which were the chief means of propagating the fatal malady. Horses, cattle, and sheep are all liable to rabies, as are feral creatures, and it was long feared that some fox or cat, rat, or other wild animal might have been rabid when the last case in a domesticated one was reported. At the time of writing, five years have elapsed since rabies was diagnosed in Britain, and it may therefore be considered as exterminated. The maintenance of the present strict quarantine laws as regards dogs can alone save us from reimportation, as, owing to the extended land frontiers of foreign countries, none have been able to free themselves as we have. See RABIES.

TUBERCULOSIS. — Until comparatively recent years this scourge of the farmer and dairyman was not recognized as infectious. The researches of Dr. Koch and others led to great public interest being taken in the subject, as Koch first expressed the opinion that bovine tuberculosis was communicable to man, through meat and milk, and afterwards modified his views when medical men and veterinarians in this country, with few exceptions, had adopted his (Koch's) original theory. Royal Commissions have investigated and reported, and it is probable that more drastic regulations will be enforced when the final report has been adopted. See TUBERCULOSIS.

Besides the diseases of animals already recognized as infectious, and called plagues when they spread rapidly and involve great numbers, there are others which from time to time appear to pass from simple or but slightly infectious forms to those of extreme or virulent variety. Influenza among horses is always present with us in a mild type; but with atmospheric or other causes, of which we are not cognizant, it assumes a serious form, and spreads with such rapidity that the wind is credited with conveying it across oceans to continents where it was not known to exist but a few weeks previously. It may even be so. We have already referred to the extreme difficulty of accounting for the spread of swine fever except by aerial movements. The rapid transit of animals from Europe to America, and of substances which have been in contact with diseased creatures, probably affords the most reasonable explanation of the celerity with which disease is now spread, as compared with the hundred years during which a plague in central Europe took to reach Britain and make its presence felt, before steam had revolutionized the world.

Apart from the specific infectious diseases of animals, and such as are transferable from them to man, or from man to beast, we may say, in a broad general sense, that the maladies from which the live stock of the farm suffer are very much the same as those endured by mankind. They are sentient beings with circulation, digestion, muscular and nervous systems modelled much on the same plan and subject to the same disorders, modified by certain structural variations. Animals are not subject to so many diseases of the brain and nervous system, and escape those heart and kidney troubles consequent upon indulgence in alcohol or the passions of hate or avarice, that men suffer; nor are they tempted to commit suicide as a consequence of erotomania; but the erotic passion is accountable for many injuries sustained by the males of many species, and females are not wholly exempt from those acute forms of dementia connected with failure to gratify sexual desire. More than one of the suspected cases of rabies (see RABIES) in cattle have been proved to be due to irregular or excessive production of ova reacting upon the brain (nymphomania).

The non-infectious or sporadic inflammatory diseases of the lungs, heart, and circulatory apparatus experienced by men exposed to conditions provocative of these maladies, are found also in animals.

Having regard to the fact that mental disturbances and habits detrimental to health in man have so much to do with the digestive troubles from which he suffers, we might suppose that animals would largely escape them. To some extent this is so, but they are placed under unnatural conditions for our convenience or profit. We develop the muscular system of the horse at the expense of the vegetative, and call upon him to do severe tasks on one day and nothing at all perhaps for several others.

For our own or the safety of the public we keep bulls tied up for lengthened periods, and expect cows to be only milking machines. The pig is deemed an animal of mean intelligence, because, confined within high walls beyond which he can see nothing, and invited to indulge the only appetite possible under the circumstances (see APPETITE), he has no opportunity of developing faculties which make him a fine performer when cultivated.

Animals are fed for our convenience, and in the usual way have no choice, hence the frequent disorders of the digestive system, which will receive consideration in another part of this work.

Confinement within buildings and inhalation of their own effluvia is a source of respiratory troubles, apart from those induced by inclemency of the weather, exposure to draughts of cold air, of which they cannot complain, or labour of an irregular or exhausting kind. Congestion of the feet (see LAMINITIS), overgrown hoofs, broken horns, and galled skins are all brought about by conditions of servitude or confinement within narrow space.

A variety of lamenesses afflict those animals employed in draught. Rheumatic and other joint evils beset the confined and over-fed animals lying upon damp bedding, and external and internal parasites have always to be reckoned with as serious factors in the rearing and keeping of all sorts of live stock. Taking the parasites alone which infest the lungs of calves, lambs, and pigs, it may be said that a profit or loss on some holdings will depend upon what measure of success is met with in combating these pests. Under the head of PARASITES, WORMS, &c., will be found the methods of propagation and the life-cycle of the chief parasites of the domesticated animals, and the most suitable means of combating them. See also CONTAGIOUS DISEASES (ANIMALS) ACTS, and also separate articles on the diseases named.

[H. L.]

Animals, Domestication of. — The practice of domesticating animals appears to have been engaged in from the very dawn of civilization. It is probable, also, that the art originated independently amongst many different races, and it has been suggested that the earliest animals domesticated were pets, selected from amongst those caught in hunting, for their beauty or other pleasing characters. This is not unlikely, since the same spirit still prompts men to tame animals. No doubt other motives, such as the stocking of live animals to provide against times of scarcity, would foster the practice, an appreciation of value for various purposes would readily arise, and animals would be kept for profit. Dogs are the oldest known domestic animals; these were doubtless kept in the first instance as pets and companions. Utilized in the chase, in due course they would in turn materially help in the keeping of other stock, such as sheep, goats, and oxen, and thus aid in developing the practice of domestication. It is likely, therefore, that domestication of animals has been of some importance in the development of civilization; the keeping and rearing of animals for food and clothing would mark the transition from the occupations of the savage hunter to those of the shepherd and breeder. Jenks, in his History of Politics, thus states the probabilities: 'As all the advantages of the rearing of animals come to be realized, the savage 'pack' gradually changes into a society of shepherds or herdsmen, in which the men are engaged in tending cattle, sheep, or goats, while to the women fall the subordinate offices of spinning the wool, milking the cows and goats, and making the butter and cheese. The men drive the flocks to pasture and water, regulate the breeding, guard the folds against enemies, decide which of the animals shall be killed for food, and break-in the beasts of burden.' The practice of rearing animals would doubtless early raise the question of selective breeding. In the case of dogs, for example, as Darwin has pointed out (Animals and Plants under Domestication), 'four or five thousand years ago various breeds, viz. pariah dogs, greyhounds, common hounds, mastiffs, house dogs, lapdogs, and turnspits, existed, more or less closely resembling our present breeds'. The changes effected in animals which become breed characters are brought about by the utilization of naturally occurring varieties in the first instance. These variations are hereditary, and are due to variations which arise in the individual germ cells and to amphimixis, that is the association of the germinal substance of the two sexes in fertilization. Such naturally arising characteristics are transmissible, and by selection can be accentuated or suppressed. They are to be clearly distinguished from 'modifications' arising during life, and due to environmental causes, such as diet, use or disuse of parts, change of climate, &c. There exists no satisfactory proof that such modifications are transmitted, although owing to the conditions under which they arise being continued for the offspring, they *appear* to be so. Under changed circumstances they usually disappear.

The particular changes effected in domestication depend upon the type of animal and the purposes for which it is utilized. They, however, involve a change in disposition sufficient at least to render them tolerant of human society, and more or less docile. These features, of course, it will be understood, are developed hereditarily; the taming of individual animals and of their offspring in turn, such as is effected with wild stock in zoological gardens or menageries, is not *in itself* to be regarded as evidence of domestication. No doubt there will arise in domesticated animals changes which are due to the manner and conditions of life, but true domestication involves, as already indicated, inborn hereditary changes. Amongst such, besides those of disposition, there are very generally included structural changes, which may be very marked and deep-seated, involving skeletal and muscular parts. An important character essential in domestication is that the animals be fertile under the altered conditions, and fertility indeed is often a character so desirable that it is fostered and increased by selective breeding.

We may now proceed to give brief notes on the origin of the commoner of our domestic animals. (For the detailed treatment of the various breeds see DOG, HORSE, &c.) *Dog.*—As already pointed out, dogs have been domesticated for thousands of years, and are probably the first animals to be so. They have in all likelihood been domesticated by different races of men at different periods, and not always from the same wild type. The number of breeds is very great, and different species of wolf, wild dog, and jackal appear to have been made use of from time to time in their evolution. *Cat.*—The Caffre Cat of Africa and southern Asia (*Felis caffra*) is regarded as the chief ancestral stock of the domestic cat. One of the reasons given in support of this view is that the whole of the sole of the hind foot is black in this species, a feature which occurs in the darker varieties of the domestic cat, whereas in the wild cat there are only spots of black. The cat was venerated by the ancient Egyptians. It is likely that other species have interbred, *e.g.* the wild cat (*Felis catus*). *Ox.*—The cattle of different parts of the world have originated in different wild stocks. In Europe there are known to have been domesticated as early as the neolithic period the *Bos primigenius*, described by Julius Cæsar as the Urus, and a smaller species (*Bos longifrons*). The latter is by some regarded as a smaller race of the former species. It has been suggested that the wild white cattle of Chillingham Park are descendants of a race of *B. primigenius* which had escaped from domestication. The small dark cattle of Wales and the Scottish Highlands are probably traceable to *B. longifrons.* The European Bison is artificially preserved in the primeval forests of Lithuania, Moldavia, Wallachia, and the Caucasus. The origin of the various breeds of European cattle now existing is uncertain. *Sheep.*—Remains of Swiss lake-dwellings show that sheep were tamed in the neolithic period. As to the domesticated forms of different regions, it is more than likely that they are of multiple origin. Our own varieties are said to have been, in part at any rate, derived from one or more existing species of wild sheep, *e.g.* the Barbary sheep (*Ovis tragelaphus*), now limited to North Africa, and the moufflon (*O. musimon*) of Corsica and Sardinia. But their origin is quite uncertain, and this suggestion is mere conjecture. *Pigs.*—European swine have in the Wild Boar

(*Sus scrofa*) their main ancestral type only. They are probably not an unmixed breed. Regarding their domestication Ainsworth Davis makes the following interesting comment:—'It is one mark that their owners have abandoned a wandering life and entered upon the agricultural stage of civilization, which is a distinct advance upon the pastoral one. We should expect, therefore, that the prehistoric races of the old world would tame the ox, sheep, and goat before turning their attention to the pig, and the evidence of the lake-dwellings of Switzerland favours such a conclusion, for in that area at any rate swine were not domesticated till the age of stone had given way to the age of bronze.' *Horse.*—The horse appears to have been domesticated from the earliest formation of human societies in the East. It is known to have been so in Egypt for more than 3000 years. It seems probable that Central Asia is the original home of the domesticated species. *Equus Prezevalskii*, a small horse from the deserts of this region, may possibly represent the ancestral line. Wild horses were extremely common in Europe in the later stone period, and there is evidence they were hunted by the men of that time and utilized as food. They were early domesticated in Europe, but it is doubtful how far the animals now existing on the Continent are derived from them. These are more probably descended 'from horses imported through Greece and Italy from Asia, derived from a still earlier domestication' (Flower and Lydekker). Horses have now undergone extremes of modification through domestication and selective breeding, as a study of the different breeds will show. The *Ass*, which is now almost as widely distributed as the horse, is regarded as of African origin. It was early domesticated by the Egyptians and other races. *Fowls.*—There exists much greater certainty regarding the origin of our domestic birds than is the case concerning mammals. There appears to be no doubt that our various breeds of fowls are all traceable to the red jungle fowl (*Gallus bankiva*) of Central India. It was probably first domesticated in Burma or neighbouring countries. The game-cock is but slightly modified from the red jungle cock. Ducks are descended from the mallard or wild duck (*Anas boschas*). Turkeys are natives of southern North America, Guinea fowls of West Africa. Pigeons were tamed by the ancient Egyptians 5000 years ago. All our numerous breeds are traceable to the wild rock pigeon (*Columba livia*). Of invertebrate animals utilized by man for domestic purposes there may be named the Honey Bee (*Apis mellifica*). The species, probably originating on the eastern shores of the Mediterranean, is now through human agency widely distributed over both the old and new worlds. (See Ainsworth Davis's *Natural History of Animals.*) [J. R.]

Animals, Functions of.—The activities of animals may be said to be dominated by their inherent necessities for growth or development on the one hand, and for reproduction on the other. These activities may be classified under the following chief heads:—*Irritability*, the function of response to stimuli, or power of feeling in the wide sense, subserved in the higher animals by the nervous system; *contractility*, the function of movement, primitively from or towards stimuli, subserved by the muscular system; *nutrition* or digestive function, *respiration*, and *excretion*, each having its corresponding system in the animal economy; lastly, there is the important function of *reproduction*, by which the continuity of animal types is maintained. The functions of nutrition, respiration, and excretion may be regarded as secondary, their office being to serve those parts of the body concerned in maintaining the growth and external relations of the animal. In the unicellular animals all these functions are necessarily performed by the same cell or protoplasmic unit; such a cell performing all the activities necessary to life is physiologically complete. In higher animals, however, that is, in all multicellular animals or Metazoa, there is a distribution of functions amongst the cells of the body, progressively specialized as we ascend the scale, with appropriate differentiation of parts. Thus, taking vertebrates as an example, we have the various systems already referred to.

Nervous System.—The parts which are specially excitable, which respond to external impressions, are the sensory end-organs; the retina of the eye to light, certain parts of the ear for sound, taste papillæ on the tongue, part of the lining of the nasal chamber for smell, tactile corpuscles of the skin for pressure and temperature. These end-organs are associated with nerves which conduct the stimuli received by the excitation of the end-organ to the nerve centres or ganglia. Such centres are contained in the brain and spinal cord. Some of them serve for the perception of the changes produced in the end-organs by the stimulus, while others preside over the activities of the muscles. As we ascend the scale, we find that in addition the brain possesses, to an increasing extent, the power of correlating present and past experiences, and of originating or inhibiting action in accordance with the judgment formed.

Muscular System.—This consists of specially contractile cells, aggregated to form the muscles on whose activity all movement depends. The muscles usually run from one part of the skeleton to another, and are attached thereto by tendons or sinews. They are stimulated by motor nerves, and have a rich blood supply. When a muscle contracts, usually under a stimulus propagated along a motor nerve, there is, of course, a change of shape—it becomes shorter and broader. The source of the energy expended in work done is the 'chemical explosion' which occurs in the fibres, for the oxygen stored up intra-molecularly in the muscle enters into rapid union with carbon compounds. Heat, carbon dioxide, and water are produced, and lactic acid is also formed. There are also changes of 'electric potential' associated with contraction of muscle.

Digestive System.—The energy expended in the various activities of the animal body or in its growth is balanced by the potential energy of the foodstuffs taken into the body. These consist of proteids, fats, carbohydrates, water, and salts in varying proportions according to the diet of the animal. Oxygen may also be regarded as forming part of the food. In higher animals the food is rendered soluble and diffusible within the food canal by the action of certain ferments made by the cells which line the gut or form the associated glands. The great peculiarity of these fermenting substances is that a small quantity can act upon a large mass of material without itself undergoing any apparent change. The various steps in the process are as follow:—In the mouth the moistened and masticated food is acted on by *ptyalin*, the ferment of the salivary glands. It converts starch into sugar. In the stomach the food is mixed with the gastric juice. In this juice there is some free hydrochloric acid and a ferment called *pepsin*—these convert proteids into peptones; the juice has a slight solvent action upon fats, and the acid upon carbohydrates. In the intestine the food is further acted upon by the secretion of the pancreas, which contains various ferments which continue the work of the stomach and salivary glands, and in addition emulsify the fats and in part split them into glycerine and fatty acid. The bile from the liver to some extent assists in digestion in various ways, and on the walls of the small intestine there are numerous small glands which secrete a juice which probably seconds the pancreatic juice. Similar glands occur on the walls of the large intestine, and these complete the digestive processes. Absorption of the digested food takes place along the whole of the digestive tract, and is conveyed to the body, where it is assimilated, partly by means of the capillaries of the portal system in the intestinal villi, and by the lacteals, into the thoracic duct, and thence into the general circulation.

Respiratory System.—The function of the lungs and their associated structures is to provide the blood with another foodstuff, viz. oxygen. In the lungs the oxygen of the air combines with a substance called hæmoglobin, contained in the red corpuscles of the blood, and by these is carried to the protoplasm of the tissues. The carbon dioxide formed as a waste product is absorbed by the serum of the blood, and so in time reaches the lungs, whence it is exhaled.

Excretory System.—The waste from the tissues, resulting in the dissimilative changes going on, is filtered out of the blood by the kidneys. These organs not only remove from the blood all the waste products resulting from the metabolism of proteids and containing nitrogen, but they maintain the composition of the blood at its normal. The processes are not explainable on the basis of simple solution or diffusion. A considerable quantity of water, traces of salts, fats, &c., leave the body by the skin, but its chief function is to protect and to regulate the temperature by variations in its blood supply.

Reproduction.—In higher animals this is effected by the union of special germ cells which arise in two different kinds of individuals (male and female). These are known respectively as spermatozoa and ova. The former are characteristically active and motile, while the latter are passive. The act of union is known as fertilization, and the origin of new individuals apart from it is unknown in higher animals. See DIGESTION, RESPIRATION, &c. [J. R.]

Animals, Laws regarding.—CARRIAGE OF ANIMALS. At common law a carrier is liable for any loss or damage to goods entrusted to him, unless such loss has happened through an unforeseen accident, which could not have been prevented by the exercise of any reasonable foresight; by the act of the king's enemies, or by the inherent vice, or tendency to take harm, of the thing carried. Contributory negligence on the part of the consignor may also relieve the carrier.' But with these exceptions a carrier, at common law, 'practically guarantees delivery of goods which he accepts for carriage'.

His liability as a carrier of live stock is not so extensive, for he is 'not an insurer to the extent that if the animal die in the course of transit the loss must fall on him'. That is to say, carriers are not liable for damage arising 'from wholly unusual and unexpected causes, but they are required to take all reasonable precautions for the security of the goods they carry which do not require from them any unusual expenditure, and the providing of which does not require any unusual sagacity or foresight'. When the consignor has furnished the truck or carriage for conveying the animals or the harness for securing them, or when the owner's servant is allowed to travel with the cattle on a free pass, the question of contributory negligence may operate so as to diminish or avoid the carrier's liability. In order to evade liability, railway companies were in the habit of putting in the receipts for goods taken, notices limiting their responsibility. To obviate this, the Railway and Canal Traffic Act of 1854 was passed, whereby it is provided that railway companies 'shall be liable for the loss of, or injury done to, any horses, cattle, or other animals, or to any articles, goods, or things in the receiving, forwarding, or delivering thereof, occasioned by the neglect or default of such Company or its servants, notwithstanding any notice, condition, or declaration made and given by such Company contrary thereto or in any wise limiting such liability'. But no greater damage can be recovered for loss or injury done to such animals beyond the sums hereinafter mentioned, viz.:—For a horse, £50; for any neat cattle, per head, £15; for any sheep or pigs, per head, £2, unless the person sending or delivering the same to such company shall at the time of delivery have declared them to be respectively of higher value than as above mentioned, in which case it shall be lawful for the company to demand a reasonable percentage upon the excess value, as compensation for increased risk and care. But the company may make conditions with regard to the receiving, forwarding, and delivering of any animals or goods, provided:—(1) A special contract is signed by the consignor or his agent; (2) the conditions are just and reasonable in the opinion of the Court. Such conditions as that the company will not be responsible for loss or damage to horses 'however caused'; for loss or damage to horses or dogs 'in any case' above certain specified values, unless the value has been declared, have been held to be unreasonable. Dogs, though not mentioned in the enumeration referred to, are within the provisions of the Act.

Apart from statute, a railway company, as a rule, is not bound to provide food or water for cattle during the journey. But see under Contagious Diseases (Animals) Acts.

Where a company contracts to carry animals to a place partly by railway and partly by sea, a condition freeing the company from liability for damage during the sea carriage from dangers of the sea, is valid as part of the contract, if published in a conspicuous manner in the office where the through booking is effected, or legibly printed on the receipt or freight note. Where the goods are carried partly over the lines of one company and partly over the lines of another, the company who accepts the goods is, apart from special condition, liable for their safe delivery to their destination.

Cruelty to Animals.—It was not till the middle of last century that legislation on purely humanitarian lines protected animals from needless cruelty. England led the way, both in the formation of societies for the prevention of cruelty, and of legislation for carrying out this end, Acts being passed in the reigns of George IV and William IV, afterwards repealed by the English Cruelty to Animals Act of 1849. This Act did not apply to Scotland, but in the following year the passing of the Cruelty to Animals (Scotland) Act, 1850, brought Scotland into line with England in this matter.

By the Acts now in force, wanton cruelty in the treatment of horses, cattle, and other domestic animals is punishable. Cruelly beating, ill-treating, overdriving, overriding, or torturing any animal is an offence, and so is the fighting or baiting any bull, badger, dog, cock, or other kind of animal. Anyone permitting or encouraging the foregoing offence is also punishable. The word 'domestic animals' now includes any horse, mare, gelding, bull, ox, cow, heifer, steer, calf, mule, ass, sheep, lamb, hog, pig, sow, goat, dog, cat, or any game or fighting cock or other domestic fowl or bird. Dogs must not be used for the purpose of drawing or helping to draw any cart, barrow, &c. The Act is meant to put down wanton cruelty or culpable neglect, gross carelessness, &c., but the performance of a painful operation on an animal, designed to increase its value, if done with reasonable skill and care, is not cruelty under the Acts; but the cutting of cocks' combs has been held to be an offence. The dishorning of cattle by sawing off their horns close to the skull has been held to be an offence in England, but not in Scotland. Neglect to provide animals with food for an unreasonable time will amount to cruelty.

The person who is liable to be prosecuted does not need to be actually on the spot at the time of the offence. For if a person neglect to do a thing that is his duty and within his power, *e.g.* providing food—to be given to animals—he may be held responsible, although the actual defect was due to a servant's carelessness. But in order to a conviction of the master, there must either be personal knowledge of the suffering to be inflicted, or obvious reason to believe that suffering will be inflicted, or gross negligence in the management of his business, whereby unnecessary suffering was caused by a servant's act.

By The Injured Animals Acts, police constables are enabled to cause horses and certain other animals, when mortally or seriously injured, to be slaughtered without the consent of the owner, provided it appear by the certificate of a duly registered veterinary surgeon that it would be cruel to keep the animal alive.

By The Wild Animals in Captivity Act (which does not apply to Scotland), any person shall be guilty of an offence who, whilst an animal is in captivity, shall by wantonly or unreasonably doing or committing any act, cause or permit unnecessary suffering to it; or infuriate, tease, or terrify it, or permit it to be so treated. The Act does not apply to any act done or any omission in the course of destroying or preparing any animal for destruction as food for mankind, nor to the hunting or coursing of any animal which has not been liberated in a mutilated or injured state in order to facilitate its capture for destruction. 'Animal' means any bird, beast, fish, or reptile not included in the English Cruelty to Animals Acts, 1849 and 1854.

In 1876 an Act was passed to regulate the practice of vivisection, since when no animal, while alive, may be subjected to painful experiments, except under the conditions laid down in the Act. Briefly, the main provisions are:—The experiment must be designed to advance knowledge useful in saving of life or alleviating suffering; it can only be performed by a person licensed in terms of the Act; the animal must be under the influence of an anæsthetic during the operation, and if likely to suffer after recovering consciousness, or if serious injury has been inflicted, it must be destroyed before the effect of the anæsthetic has ceased. Under certain conditions experiments may be performed without anæsthetics if it be shown that insensibility cannot be produced without frustrating the objects of the experiment.

Liability for Damage caused by Dangerous Animals.—The ground of liability is the owner's knowledge of the animal's propensities. This is inferred against the owner in the case of animals naturally ferocious, but requires to be proved in the case of animals not naturally ferocious.

1. *Animals naturally ferocious.* — Whoever keeps an animal accustomed to attack mankind is presumed to have knowledge of its propensity, and is liable in damages to a person attacked and injured, without any averment of negligence or default in the securing or taking care of it. The only condition on which such animals can be kept is the absolute insurance of the public against attack; and even if the animal be set free by some force beyond the control of the owner, or by the malicious act of a third party, the owner is not thereby relieved of responsibility. The only competent defence will be that the party injured was himself respon-

sible for the attack. Animals which have been held to be ferocious are animals which have never been domesticated, such as lions, tigers, monkeys, bears, wild boars, elephants, &c.

2. *Animals not naturally ferocious.* — Dogs, horses, cattle, &c., are not naturally ferocious, and to ground liability for injuries to persons, there must be proof that their ferocity was, previous to the injury, known to the owner or those whose knowledge is imputable to him, as, *e.g.*, his wife, or his servant in charge of the animal. But if such knowledge (termed in law 'scienter') is proved, then the liability is as extensive as in the case of animals naturally ferocious, *i.e.* he must absolutely secure the public against attack from the animal. Some animals usually domesticated are more easily infuriated than others, *e.g.* a boar, and in such cases the owner must take absolute precautions against its escape. But horses, cattle, dogs, &c., only require to be kept in a way which is reasonably secure, unless vice has actually manifested itself. If, however, exciting circumstances exist, *e.g.* smell of blood and offal from a slaughter-house, extra precautions must be adopted to meet these circumstances, and failure to do so may ground liability for damage done in consequence.

In order to ground liability for the bite of a dog, it is not necessary to prove that it has previously bitten any person, the common belief that 'a dog is entitled to one worry' being merely the popular expression of the legal necessity to show previous knowledge on the part of the owner of the dangerous propensity of the animal. Less than an actual bite may be sufficient to show such knowledge: thus a habit of rushing at persons though out of reach, and attempts to bite, if known to the owner or those whose knowledge is imputable to him, may be sufficient to ground liability for injury done. The fact of a dog having previously bitten cattle does not, however, infer a knowledge of a propensity to attack human beings. If the person injured has by his conduct provoked the attack, or has improperly gone within reach of a watch-dog, he has no claim. In the same way, a person who is *unlawfully* on private premises, *e.g.* in a house, has no claim for injury to him, done by a dog.

It is permissible to keep a ferocious dog for the protection of a house, and the owner may turn it loose at night. It is, however, unlawful to keep it where it might attack a person innocently approaching the place for a lawful purpose, or dangerously near a path, even though a private one, nor will the notice 'Beware of the dog' protect the owner if in point of fact it was not read.

A person attacked by a ferocious animal may kill it in self-defence, but only when it is actually attacking him, not after the danger has ceased.

In the case of injuries by dogs to cattle, it is provided by statute that it is not necessary for the person sustaining the loss to show a previous mischievous propensity in the dog, or the owner's knowledge thereof, or to show that the injury was attributable to neglect on the part of the owner. See under DOG.

The person in custody of the animal naturally ferocious, or known to the custodier to be ferocious, is liable equally with the owner for its acts. Thus a carrier who has notice of the vicious propensity, either from the knowledge of the animal's nature, or by previous notice from the owner, or from tendencies clearly shown by the animal while in his custody, may be liable for damage done. In the same way, one who harbours a dog, or even permits it to remain about his premises, may become liable for injuries done by it. But there will be no liability for the acts of a stray animal unless there has been undue delay or carelessness in getting rid of it.

PROPERTY IN WILD ANIMALS.—The common law regards wild beasts as *res nullius*, or the property of no man, so long as they remain in their natural state, holding that they become the property of the captor, and that until 'reduced into possession' the appropriation of them is not an act of theft. Therefore, although the right of killing game is now an incident of real property, and considerations of the evils of trespass, &c., have led to the enactment of the Game Laws, yet 'all game, even what is catched in contravention of these Acts, becomes the property of the catcher unless where the confiscation thereof is made part of the penalty' or where it has in some way been reduced into the possession of the landowner. To this general statement the only exception is that of the 'Royal fish' or whale. If of large size, and captured within territorial waters, it belongs to the Crown, but if of smaller size, it falls to the captor in accordance with the general rule above stated. When a wild animal which has been captured has regained its liberty, the ownership of its first captor immediately ceases, and the property will fall to its next captor. Bees in a hive are private property, and while they are hiving, so long as the owner is in pursuit, the property in them remains in him. See also GAME LAWS. [D. B.]

Animals, Slaughter of.—The necessary slaughter of animals is performed in a variety of ways. That it is carried on in the British Islands in a humane manner, and under restrictions calculated to protect animals from cruelty, is admitted by all save a few persons with a Brahminian regard for life, and who may be considered as irreconcilable to any slaying and eating of flesh. That inspection of private slaughter-houses is not quite what it should be is no doubt true, but on the whole such places are frequently examined and always liable to surprise visits, and it is but just to slaughtermen to say that they are both skilful and merciful in carrying out their unattractive work.

The earliest records prove that some preliminary fasting was found desirable in the case of animals to be killed for food, but this custom was not always observed when they were destined for religious sacrifice.

A period of fasting varying from twenty to forty hours is the custom of most civilized peoples before slaughtering animals for food.

INSTRUMENTS.—The poleaxe, the sledge hammer, and the knife (sometimes the hatchet) are the chief implements employed. The bullock to be killed is secured by a noose round the neck attached to a winch, whereby he is drawn to a fixed block or ring staple low down against a wall. Another staple situated a few feet farther back is utilized to effect his fall to the ground with a minimum of violence and bruising. Through this a rope is passed and attached to the outside hind leg, just above the foot. With head already pulled down, no great amount of force is necessary to make him sink rather than fall to the ground. Then the fatal blow is struck, midway between the top of the forehead and a line drawn between the eyes. Any heavy implement, as a sledge hammer, will fell him, but preference is given to the poleaxe as giving easy access to the brain with a cane or flexible stick to complete the destruction of sensibility. Slaughtermen are still much in favour of the poleaxe, preferring it to the more refined instruments now to be seen at public abattoirs, at police stations, and on horse ships or cattle boats. Greenyer's humane killer (figs. 2, 3) has the advantage of being placed on the spot, without risk of a foul blow or miss on the part of the slaughterman. A light blow on the end of the piston rod discharges a cartridge, killing the beast without fail, and leaving the necessary opening for the 'pithing' cane or stick previously mentioned. There is one objection to a bullet, in that it is apt to come out some distance down the neck or behind the ribs with sufficient velocity to injure anyone in its track. The same thing, of course, applies to shooting with rifle or pistol. The next procedure is to lay open the skin at the lower portion of the neck, separate the muscles and the fat, draw out the much-prized 'bread', and then divide the great vessel (anterior aorta) there situated. The animal is quite insensible while this is dexterously performed, and the blood gushes out in great volume. Its flow is promoted by rocking the dying beast to and fro by means of a cord attached to the uppermost front leg, while the man's foot is used against the ribs, high up. The details that follow belong rather to the butcher, and are outside the purpose of this article.

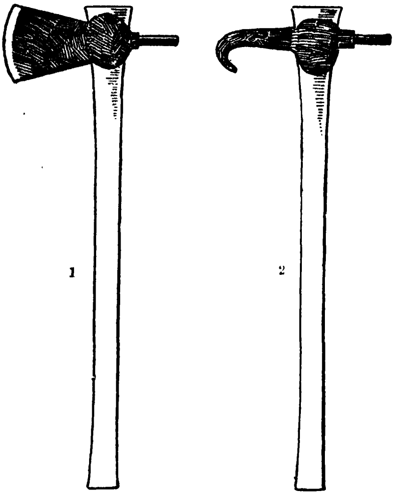
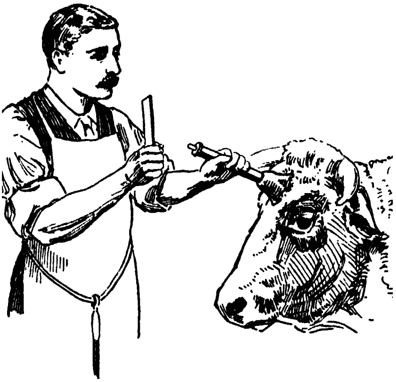


Fig. 1.—Poleaxes

1, Ordinary pattern. 2, London pattern



ig. 2.—Stunning Bullock with Greenyer's Humane Killer

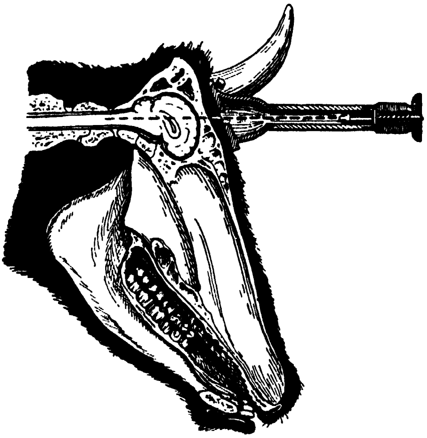


Fig. 3.—Section of Bullock's Skull, with Greenyer Apparatus in position

Slaughter of Sheep.—These are not poleaxed, but placed upon a low wooden tray on wheels and known as a 'crutch'. They require no trammels, the man or boy assisting merely holds the sheep on its side. The head is extended backwards by the slaughterman, who thrusts a rather wide-bladed knife right through the neck from the angle of the jaw, coming out on the under side. A rapid turn is given to the knife, and its cutting edge brought in contact with the spinal cord or 'pith' at the point between the occiput and first bone of the neck (atlas). The division of the cord at this place has the same effect of destroying sensation as the crushing of the brain in beasts by means of the poleaxe. The severance of so many and large vessels in the neck has the effect of rapidly withdrawing the blood, but not quite all that is desired. Some blood remains in the large vessels of the chest which it is the custom to divide in killing bullocks. This is presently let out when the carcass has been drawn up for skinning. If not well bled, the superficial veins spoil the appearance of the carcass, as more or less dark blood will remain in them to tell the expert in meat inspection. The crutch is not an indispensable vehicle, and many farmers and others without assistance find it convenient to tie the legs together and kill in the manner above described, taking additional care to prevent clotting or other hindrance to that free bleeding which is so desirable if a carcass is to both look and keep well.

PIGS.—Varying so greatly in size and capacity to resist control, different methods are adopted to bring them to the slaughter. The larger animals are noosed by a rope passed behind the tushes or large teeth in the upper jaw. Sometimes the lower jaw is noosed, but fracture has been known to follow, and the practice is not to be commended. Being brought to a fixed point, the knife is plunged into the chest, dividing those great vessels there situated. A good pig killer expects to do this with one stab, but persons less expert will lay open the skin and follow the course described in connection with the killing of cattle.

It is the least humane method of killing animals adopted generally in this country, and there appears to be no better reason than that of saving the head from injury as a 'joint'.

After a pig is 'stuck', he will squeal and struggle until syncope puts an end to his life. The carcass is quickly conveyed to a tub of boiling water, to be scalded and thereby freed from the outer cuticle; but there are persons, especially in the western counties, who prefer surface-burning by a fire of shavings or other quickly consumed materials.

The slaughter of sick or injured animals not intended for human food may be effected in other ways than those already described, although it may well be doubted if any means is so swift and merciful as the charge of shot at close quarters. Pithing is effected by the dexterous division of the spinal cord at the poll, but should not be attempted by anyone without accurate knowledge of the parts. A narrow-bladed sharp knife is all that is needed.

Unless an animal is unapproachable on account of delirium, his death may always be accomplished by the knife, the operator having no more to do than sever the great vessels. If the head can be elevated and the skin thereby tightened over the throat, the operation will be facilitated. A bold strong sweep of the knife, severing the vessels and the windpipe too, will shorten the time during which the animal stands and bleeds, resisting the sensation of syncope or fainting as long as possible.

Death may be caused in animals by the sudden introduction of air into a vein. An incision is first made into the jugular vein, which is previously distended by a cord tight drawn around the neck as for bleeding with a fleam (see BLEEDING), then a blowpipe pushed in and air forced down in the direction of the heart. This operation, like pithing, and stabbing in the chest, needs considerable skill, and should not be attempted without previous instruction.

Small animals, as rabbits, are destroyed by a smart blow behind the ear, while the creature is suspended by the hind legs. This breaks the neck or injures the spinal cord at the point where pithing is done in the large animals. Stretching the neck, as it is called, is performed by one person holding the hind limbs in his left hand in front of him, while giving a jerking and extension movement by means of the right, in a downward and backward direction from his own body. See POULTRY.

JEWISH METHODS OF SLAUGHTER.—The killing of animals 'according to Jewish ritual' has been often pronounced cruel by persons acquainted with the 'gentile' or ordinary means adopted in Christian countries. It does appear so, having regard to the time occupied between the act of slaughter and the cessation of all movements. A Jewish official, and not necessarily a butcher by trade, does nothing else to the beast but cut its throat and superintend the remainder of the work. A special knife is used, and only the officer handles it. He is most punctilious as to cleanliness, and with a slate rubber very carefully sharpens the edge after every act of slaughter, it being deemed a serious offence against the rules to use a knife with the slightest gap or imperfection of the edge.

The custom as to fasting does not differ materially from that adopted by other peoples.

The bullock to be slain is noosed by the horns and drawn to the block. The outside hind leg (the animal is close to the wall, as described in connection with the gentile methods) is secured by a rope to a staple in the wall. Then the two front legs are hobbled, and the animal is pulled down with the then uppermost hind leg free. One free leg somewhat reduces the violence of the fall. A little later this limb is secured by a loose cord. The head is now directed in such a manner as to make the animal's face lie on the ground with his throat upwards. A ring of twisted leather or rope is pushed over the jaw and into the mouth, and under this ring an iron bar is passed and fixed securely under the horn or back of the head. By this the head is maintained quite still, and the skin drawn tight over the throat by the executioner, who now selects a position opposite the second or third cervical vertebra, and much lower than that referred to in connection with the killing of sheep. With one clean, bold stroke at right angles to the neck, the skin, muscles, carotid arteries, and veins are all severed, and two strong streams of blood pour out with great force. The prolonged struggles of the animal, and the distressing noise made by air rushing in through the severed windpipe, convey the impression of pain; but it is extremely doubtful if the beast is conscious, after the first gush of blood from divided vessels so large. The cutting-off of the supply of blood to the brain, while the severance of the veins quickly empties the head, must result in insensibility, and the subsequent movements need not imply suffering.

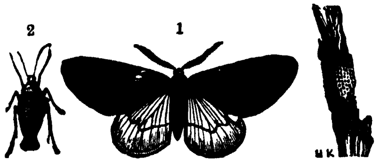
Calves have the hocks tied together, and by the cord are slung from the ground sufficiently high for a man to hold the two front legs back, bending them at the knees, while the neck is stretched conveniently for the stroke across it of the knife, in the same manner and at the same place as described in connection with bullocks and sheep.

Sheep.—The legs of sheep are tied together. Three are first bound, the two front and the right hind, the animal being held on its right side in a 'crutch', not distinguishable from the stollidge used for barrels, but of regulation make and according to the ritual. Thus secured, the executioner proceeds to hold back the head, part the wool, pulling out a very little, perhaps, in order to expose the skin, rendered tight over the region to be cut. Precisely the same method is adopted here as with the bullock previously described, but the blood is caught in a tray.

Fowls are doubled up in the hands of the killer by holding the legs and wings in one hand, then pressing over the head until secured by the same hand, thus making the neck arched and the skin tightened over the part to be cut. At about the same relative position to that adopted in killing quadrupeds, the throat is now cut across, the head bent back to bring out the severed top end of the windpipe, then slackened to let the protruding portion return. The fowl is held in this position while most of the blood escapes, but it does not do so to the extent of the accumulation in the loose tissues of the neck of a fowl whose neck is properly broken and pulled out—'stretched', as it is called. [H. L.]

Anise, Aniseed.—This is a bald annual plant belonging to the nat. ord. Umbelliferæ, and the technical name is *Pimpinella Anisum*, L. The plant is about 1½ ft. high. It produces two kinds of leaves; those on the ground are roundish and almost entire, whereas those up on the stem are elongated and cut into segments. The small flowers are white and clustered in compound umbels at the ends of the leafy branches. When ripe, each flower becomes a narrow hairy fruit. These fruits are the valuable part of the plant, since they contain the oil of anise which communicates its flavour to the cordials or liqueurs called *Aniseed* or *Anisette*. The Anise is a native of Eastern Asia, Egypt, and the Mediterranean coasts. It is cultivated for its aromatic fruits in France, Germany, and all along the Mediterranean. In Germany an acre of Anise yields about 270 lb. of the fruit 'Aniseed' or 'Anise seed' of commerce. [A. N. M'A.]

Anisopteryx æscularia (The March Moth).—Fruit trees of all kinds are attacked by the larvæ of this moth. As in the Winter Moth, the females are wingless. The male has ample wings, the front ones greyish-brown with two paler waved lines across them; hind wings pale-grey, with an indistinct dusky band and central dusky spot; wing expanse 1¼ to 1½ in. The female is quite apterous. It appears in March and April. The female crawls up the trunks of the trees and lays her eggs in bands of nearly half an inch across, encircling the twigs. They hatch in April. The larvæ are cylindrical and thin, bright-green strongly tinged with yellow, with a darker green line edged with grey down the back, with two paler lateral lines, and between them a fine pale-grey line; divisions of the segments yellow, spiracles black. They are typical 'loopers' and feed on the foliage, reaching an inch in length. They mature in July, and pupate in a cocoon in the ground. *Treatment* as for Winter Moth, but grease bands must be kept on later. [F. V. T.]



March Moth (*Anisopteryx æscularia*)

1, Winged male. 2, Wingless female. 3, Band of eggs.

Anjou Cabbage. See CABBAGE.

Annatto. — A colouring matter derived from the fruit of *Bixa Orellana*, a small tree which grows in South America, used for colouring milk, butter, and cheese. The colour given by annatto approaches very nearly to the natural colouring matter of milk fat.

The colouring matters, of which there are several, are contained in the pulp which surrounds the seeds, and give them a bright-red appearance. The pulp is separated from the seeds by bruising, shaking with water, and straining, and allowing the liquid to stand till the coloured substance subsides. Another method is to cover the seeds with water, and leave them several days to ferment; the colouring matter is then very easily removed.

For colouring milk, a solution is made by boiling the deposited pulp (or even the seeds themselves after fermentation) with sodium carbonate to which some caustic soda is added; this gives a deep reddish-brown solution containing about 2 per cent of actual colouring matter. The amount of solution added to milk varies from 1 part to 30,000 of milk to 1 part to 10,000; it is principally used in large towns where the public taste demands a highly coloured milk, the quality of the milk being erroneously judged by its colour. For this purpose, however, annatto is now sometimes replaced by synthetic colouring matters; of these, methyl orange and phosphine give nearly similar colours, and as they can be prepared in stronger solution they have some vogue.

For colouring butter and cheese, a solution of annatto in an oil, usually cotton-seed or sesamé oil, is used. It is employed in this form, as it mixes with the fat, and thus passes entirely into the product.

The colouring of butter and cheese is undertaken to preserve a continuity of colour throughout the year, and appears to be legitimate. The colouring of milk is usually done to give a fictitious appearance of richness, and the Committee on Preservatives and Colouring Matters in Foods, appointed by the President of the Local Government Board, recommended its prohibition. [H. D. R.]

Annelida.—The most highly organized of the animals popularly known as 'worms'. They are so termed on account of the fact that all the typical members of the group exhibit externally a succession of rings, the outward signs of internal segmentation. Other distinctive features are a nervous system, consisting of a pair of cerebral ganglia lying dorsally, a connecting ring round the gullet, and a ventral chain having ganglia corresponding to each segment. There is a blood vascular system, and paired segmental excretory organs. Besides primitive, aberrant, and degenerate parasitic forms, there are three well-defined groups, viz.: the Polychæta, which are all marine. Familiar examples are the Fisherman's Lobworm and the 'Sea Mouse'. The Oligochæta, which live in fresh water or in the soil, *e.g.* earthworm, constitute another subdivision. These two groups are classed together as Chætopoda, or bristle-footed. The third group is constituted by the leeches, or Discophora, in which bristles are absent, and which usually possess two suckers, one at each end of the body. See EARTHWORM, LEECH, &c. [J. R.]

Annual Meadow Grass, a species of the genus Poa common on all soils, and especially on waste ground. See MEADOW GRASSES.

Annual Plants.—The term *annual* is applied to all plants which complete the whole course of their vegetative and reproductive life in a single season. They are raised from seed, produce leaves and flowers, and ripen their seeds, all in the course of a season. No store of food is left behind, and no buds are produced which might continue their growth for another year. In this respect annuals stand in sharp contrast with biennial and perennial plants.

Plants such as chickweed and groundsel complete their life in a few weeks, and during a single season may produce a second or even a third crop, each crop starting from seed. In such cases the special name *ephemeral* is applied.

Among annual grasses may be noted all our cereals—barley, wheat, rye, and oat, also annual rye grass, annual meadow grass, and brome or goose grass.

Among Cruciferous annuals may be noted the Mustard weeds, namely, Runch or Wild Radish, and Charlock or Skelloch.

Although annuals produce seed but once, the important point must not be overlooked that all their energies and all their available substance are devoted to seed-making. This peculiarity confers upon these shortlived plants the power of producing an abnormally large number of seeds in a short space of time. The seeds are there by the hundred, and so it is easy to understand with what rapidity a few weeds may take possession of arable land and overrun it.

Another important point about the annual weed is its smartness at seizing hold of available supplies in the soil. If there is any scarcity of water supply, any scarcity of phosphate or nitrate, the annual weed is not slack to seize what is going, and thus the crop plant alongside is short of supplies and stunted, at the very time when the most abundant supply is desirable for vigorous growth. This explains the extraordinary diminution of crop which results when apparently only a few mustard weeds are present in the oat crop. If a corresponding oat crop is grown alongside, and the weeds therein are destroyed by spraying, the increase of yield is almost incredible unless one has seen such an experiment carried out.

The principle underlying the destruction of annual weeds is—prevent seeding, for annuals can reproduce and spread only by seeds. See also art. on AGE OF PLANTS. [A. N. M'A.]

Annuals. — In a garden sense the term *annuals* includes a large number of useful, hardy, easily-grown plants, and it is surprising how much may be done to beautify the garden for the greater part of the year by a free use of them. Generally the seeds are sown in March, at a time when the soil is loose and the weather favourable. They are sown thinly, and raked in or covered with a thin layer of prepared fine soil, the general rule being to cover the seeds to the depth of their own diameter. As soon as the seedlings appear above the soil they require attention, watering them should the weather be dry, and protecting with a little hay or some such covering shaken thinly over them for the night in the event of frost, removing it the next morning as the sun shines. The cultivation of radishes and lettuces does not differ from that of hardy annuals. They require to be protected from birds, and to be judiciously thinned as soon as they can be handled. After this a topdressing or mulch with prepared soil may be given with advantage, and the young plants must be regularly supplied with water should the weather be at all dry. This is particularly necessary where the soil is light. Some annuals can only be successfully grown when the seeds are sown in boxes under cover, and the seedlings transplanted to the border or bed outside at the commencement of summer. China Asters, Stocks, Verbenas, Balsams, Petunias, Lobelias, and Zinnias are best when thus treated, whereas such plants as Mignonette, Musk, Pansy, Marigold, Clarkia, Godetia, Iberis, Nemophila, Linum, Tropæolum, Œnothera, Marvel of Peru, Poppy, Larkspur, Sunflower, Forget-me-not, Sweet Pea, Coryopsis, Lupin, Salpiglossis, and Helichrysum may be sown at once in the positions where they are to flower, and treated as above recommended. Some of the grasses, too, such as Indian Corn, Quaking Grass, the Animated Oat, Lovegrass, and Hare's Tail, may be used as garden annuals. The taller-growing plants will need some support, which should be provided as soon as they have been thinned. A garden filled wholly with annuals, if judiciously selected and well managed, is as interesting and enjoyable as the most costly of plants would be. They may be sown in rose beds, along the front of borders, or where bulbs such as Gladiolus are grown. The seeds are so cheap that it is scarcely worth while to save them at home; but should it be desired to preserve any particular kind, this is easily done by allowing the plants to remain until the seeds are ripe, when they may be pulled up, put into a paper bag, and hung in the dry until they are quite ripe. All seeds are best preserved in a drawer or wooden box, kept in a dry place where the temperature is about 60°. Some annuals, such as named sorts of pansies, are perpetuated by means of cuttings. The cuttings are taken off in July, inserted in boxes of light soil, and placed in a shady position, where they should receive daily watering until they are rooted. [W. W.]

Anobium domesticum (Large Death-watch Beetle).—This beetle and its larvæ tunnel into and destroy the woodwork of old houses and barns, &c. It is about ⅙ in. long, of a dark-brown colour, and has the head sunk into the thorax, which rises cowl-like over it. They tunnel into dead wood of all kinds, where their eggs are laid. The larvæ also tunnel into the wood; they are white, thick, and fleshy, with six legs in front; they become pupæ in their burrows, in a silken cocoon combined with wood dust. The beetles hatch some time before they escape, when they leave behind them shot-like holes in the woodwork. The adults, by means of their head, produce a loud, ticking sound in the wood, the 'death-watch ticking'. Furniture also suffers largely from it. *Anobium paniceum* is shorter, broader, and paler; it is almost omnivorous; it attacks all dried vegetable substances as well as wood, such as biscuits, bread, and even Cayenne pepper. See XESTOBIUM for treatment. [F. V. T.]

Anopheles maculipennis (Spotted Winged Anopheles).—A brownish mosquito with spotted wings. The palpi of the female are as long as the piercing proboscis; in the male longer and clubbed at the apex. The female feeds upon the blood of man and animals, the male upon the nectar of flowers. This is one of the mosquitoes that is the host and the carrier of malarial fever from man to man. The adults hibernate in cellars and outhouses. The eggs are laid singly on water, but collect together in small star-shaped groups. The larvæ ('wrigglers') are entirely aquatic, and move about rapidly in the water; when at rest on the surface they lie nearly parallel with it. Pupation takes place in the water; the pupa having two horn-like breathing tubes in front, and is capable of free movement. It occurs in Europe, North America, and parts of North Africa. When resting, Anopheles look like a thorn stuck in the resting surface, and thus differing from Culex (see CULEX). They may be destroyed by putting paraffin on the small collections of water in which they live. [F. V. T.]

Anorthite, one of the felspar group of minerals having lime as one of the bases. See FELSPARS.

Ant in Relation to Soil.—Ants belong to the order of insects known as Hymenoptera, which includes also the Wasps, Bees, Sawflies, &c. They constitute the family Formicidæ, of which there are numerous species, at least 2000 being known, and probably as many more exist as yet undescribed. They occur in all parts of the world, being particularly abundant in the Tropics. They are social insects, living in communities consisting of males, females, and workers, which are undeveloped females. In most species there are different types of worker, such as nurses, soldiers, &c., each having appropriate duties to perform. The majority act as nurses, feeding the larvæ by disgorging honey from their crops. They carry them about, laying them out in the different chambers within the nest, according to the temperature, humidity, and so on. This nursing is continued while the insects are in the pupal state. The Ants which emerge from the pupæ are either winged or wingless; the wingless are imperfect females—the various types of worker—the winged insects are fully-developed males and females. Pairing takes place between these in the air, whither they rise for their nuptial flight. The males are short-lived, dying soon after; the females, or queens as they are termed, return to the earth, shed their wings, and establish new colonies, in which for the rest of their lives they devote themselves to the production of eggs. Sometimes queens are adopted into old nests, and there may be several fertile females in the same nest. Since the males are so short-lived, the bulk of the members of a colony generally consist only of workers and fertile females or queens. Ants exhibit many remarkable instincts, and some intelligence. The workers collect honey, fruit, and insect juices, &c., storing it in their crops to be disgorged to the stay-at-home nurses, queens, and grubs. Some collect portions of leaves, which they cut down, and upon which they cultivate a fungus for food (Leaf-cutting Ants); others store grain, some carry on wars, capture slaves, or keep domestic animals in the shape of plantlice or aphides.

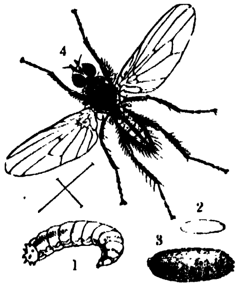
The habitations of Ants are very different from those of their near relatives, the Bees and Wasps. They generally consist of a number of irregular chambers, connected by many cleverly constructed passages. They may be immediately below the surface of the ground, or extend to a considerable depth, or be i part above the surrounding level. A common form consists of underground chambers and galleries immediately below a large stone. On lifting such a stone, one frequently finds the grubs laid out on the surface of the ground just below. These, on being exposed by the removal of the stone, are at once seized by the workers and carried below with all possible speed. In some cases the galleries and tunnels of such a nest extend far below ground. Other Ants build chambers above-ground of more or less firmly cemented walls; still others form burrows in the stumps of trees or in old wood. *Formica rufa* (the Red Ant, Horse Ant, &c.), a well-known species, collects pine needles, bits of stick, &c., heaping them into conical masses above-ground. These heaps are sometimes as high as 3 ft., and nearly 6 ft. in diameter; they are extensively galleried with tunnels extending into the ground below. There are generally paths passing from the nest in various directions. The roads made by Ants are actually prepared by the removal of obstacles, or by tunnelling or arching over to form covered passages. Where anthills are numerous and of large size they without doubt materially affect the character of the soil. An important result is the very thorough aeration effected wherever the ramifications of the nests extend. A further result of the operations of the Ants in such cases is a considerable circulation of soil materials. This is particularly the case with regard to some foreign species. The habitations of the Leaf-cutting Ants (Atta) of tropical America are low mounds of bare earth, some of which have been noted with a circumference of about 40 yd. The earth of these mounds is frequently different from that of the surface, having been brought up from the subsoil. The Ants are continually bringing fresh earth from below and exposing it upon the surface. Their chambers and galleries below extend to an even greater distance than the mound above, and are further of considerable depth. The 'Bull-dog' Ants of Australia (Myrmecia) form large mounds of earth, which are sometimes 5 ft. high, and which occur in immense numbers. In our own country, anthills sometimes occur in neglected meadow lands in very large numbers, and ants' nests of various kinds are by no means uncommon all over the country in fields, moors, and woodlands.

Of similar habits, though by no means closely related to Ants, are the Termites or White Ants. These occur in tropical or warmer temperate regions, they are not found in this country. They live in large communities consisting of fertile males and females, which after their nuptial flight lose their wings, and infertile workers, which, unlike the Ants, are both male and female. These never possess wings. There is rarely more than one fertile male and female, 'king and queen', in a colony. The queen is a remarkable-looking creature; her abdomen is immensely swollen with eggs, which she produces sometimes at the rate of one per second, continuing the process for months. The workers forage and mine, attend the royal pair, feed and nurse the young. The soldiers are larger, with big heads and powerful mandibles; they act as sentries at the mouths of the tunnels, and readily attack intruders in the form of true Ants. A favourite food of the White Ants is wood, which they devour with great rapidity, 'houses and decaying forest trees, furniture and fences, fall under the jaws of the hungry Termites'. They also eat each other's excrement again and again, and when at last it is exhausted of nourishment they build it into their tunnel walls. Some of the tropical species build earthen hills as high as 20 ft. Although they are blind they shun the light, and when on the march across country, or when climbing trees or buildings, they build galleries of earth, within which they conceal themselves. These tunnels run from beneath the soil up the sides of the trees and posts; 'grain after grain is carried from beneath, and mortared with a sticky secretion into a reddish sandpaper-like tube; this is rapidly extended to a great height — even of 30 ft. from the ground—till some dead branch is reached'. Professor Drummond, from whom the foregoing quotation is made, was of opinion that the White Ant was to be regarded as an important agricultural agent in the localities where it occurred. He says: 'As many trees in a forest are thus plastered with tunnels, and as there are besides elaborate subterranean galleries and huge obelisk-like anthills, sometimes 10 to 15 ft. high, it must be granted that the Termites, like the earthworms, keep the soil circulating. The earth tubes crumble to dust, which is scattered by the wind; the rains lash the forests and soils with fury, and wash off the loosened grains to swell the alluvium of a distant valley.' Termites are further beneficial as scavengers, in removing dead and decaying wood which otherwise would cumber the ground. In Queensland, where the nests sometimes reach a height of 15 ft., the natives clear them out and use them as ovens. Lastly, it may be stated that although Termites are in a state of nature beneficial, near human habitations they are often serious pests, completely destroying the woodwork and furniture of houses, and even books, before their presence is discovered, so rapidly do they work. [J. R.]

Anthemis, an important genus of composite plants to which several species of camomile belong. See CAMOMILE.

Anthocoris confusus and **nemorum** (Small Needle-nosed Bugs).—These two bugs are frequently found in hop gardens, and do some damage by puncturing the bine, which then ceases to revolve. At the same time both these 'bugs' are known to suck the juices of aphides. The former species is ⅕ inch long; head and just behind it black, also scutellum; elytra or upper wings dull-brown, finely pubescent, membrane dusky, with a pale spot on each side, and base white; legs pitchy-brown, tibiæ and tarsi paler than the femora. When found to be doing harm on hops, they must be collected by jarring. [F. V. T.]

Anthomyia gnava.—The maggots of this fly are said by Curtis to infest turnips in the autumn, forming cavities in the bulbs. The male fly has a black trunk and legs; body linear, of an ash colour, with testaceous bands and black dorsal spots. Female, ash-coloured, with a black line down the body broadest at the



Root Turnip Fly (*Anthomyia gnava*)

1, Maggot (magnified). 2, 3, Pupa, nat. size and magnified. 4, Male fly, magnified. 5, Nat. size.

base. Nothing is now known of it, and it is only looked upon as a doubtful British species.

A. radicum (Root Turnip Fly) is similar in its habits to the last. The maggot lives in the roots in summer, and is like the other, but has a greenish stripe down the extremity of the back; they change in the soil to clay-coloured pupæ—and the flies hatch in April (see accompanying illustration). They also resemble *Phorbia brassicæ*, but the male has a satiny-ochreous face reflecting white, with a rusty stripe on the forehead; trunk black, sides grey, with three dark stripes down the back; body narrow, shining grey, a black stripe on the middle, edges of the segments also black; legs long, black, and bristly (see fig. 4); female, very like *P. brassicæ*, but it has three smoky stripes on the trunk, and a narrow dark line along the back. [J. C.]

Anthonomus pomorum (Apple-blossom Weevil).—This weevil is the cause of so-called 'capped' blossoms. It is a serious apple pest in Kent, Worcestershire, &c. The weevil is $\frac{1}{8}$ to $\frac{1}{6}$ in. long. Colour pitchy-black, clothed when freshly hatched with ashy-grey pubescence, with a paler, broad V-shaped mark on the wing-cases. The beetle hibernates under bark, moss, and lichens of apple and other trees. It comes forth before the trusses open, and pairs. The female then lays a single egg in each young unopened blossom. Egg-laying continues for two weeks. Fifty eggs may be laid by one female. In from five to seven days the ova hatch into pale-creamy footless maggots, which mature in from eight to twenty-one days. The maggot then changes to a pupa in the blossom, which fails to expand and dies. The weevil, after seven to fourteen days in the pupal condition, escapes from the blossom by eating its way out, and lives on until the following spring.

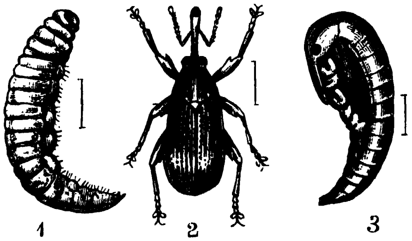


Fig. 1.—Apple-blossom Weevil (*Anthonomus pomorum*)

1, Larva. 2, Adult. 3, Pupa.

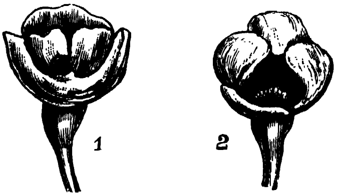


Fig. 2.—Apple Blossoms damaged by Apple Weevil (*Anthonomus pomorum*)

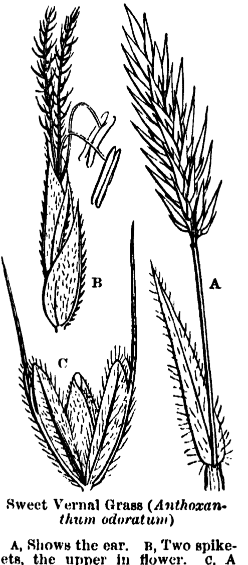
1, Showing hole of escape of adult. 2, Larva *in situ*

Treatment consists of jarring off the beetles on to tarred cloths, and jarring off the 'capped' blossoms, which readily fall, collecting and burning the same before the beetles escape.

Anthonomus rubi (Raspberry and Strawberry Anthonomus).—This small weevil works differently to the above, but is closely related. It is unicolorous, black, and reaches much the same size. It lays its eggs in unopened raspberry and strawberry blossoms in the latter half of May, a single egg in each blossom. It then passes to a little below the bud and punctures the strig, and the bud soon falls or bends over and withers. The maggot changes to the pupa in the bud, and in seven to eight days the weevil escapes from the dead blossom. The weevils injure the young shoots and leaves also by puncturing them. The adults hibernate like the Apple-blossom Weevil.

Collection of the beetles is the only preventive. [F. V. T.]

Anthoxanthum.—This genus of grasses belongs to the division with one-flowered spikelets, collected into a compact spike-like panicle. Each spikelet has two very unequal membranous glumes, lined by a pair of hairy *inner* glumes, each having an awn at its back, and embracing the floret, which consists of a pair of small thin scales, containing *two* stamens and the pistil, with a pair of erect feather-like styles. The *inner* glumes and the *bistaminate* flower are characteristic of this genus; the other grasses want the inner glumes, and have three stamens per flower.



Sweet Vernal Grass (*Anthoxanthum odoratum*)

A, Shows the ear. B, Two spikelets, the upper in flower. C, A ripe spikelet with the outer glumes removed.

A. odoratum (Sweet Vernal Grass, Spring Grass) is a fibrous-rooted perennial, growing about 1 ft. high, and producing a few leaves of a light bright-green colour, slightly coated with hairs. The ear appears as if spiked, but is in reality a panicle whose branches are contracted. The ear is at first brownish-green, but eventually becomes straw-coloured.

The flowerless shoots of Sweet Vernal are easily recognized by the pair of rounded ears at the base of each leaf-blade. These ears have usually long whiskers of hair. When the blade is chewed the taste is very characteristic, because of the presence of the fragrant substance called *cumarine*, which acts equally on the palate and on the nose. The plant thrives in rich meadows and in poor mountain pastures, whether among rushes or among heaths; on exposed sandy links and in the shaded wood, Sweet Vernal is equally at home. It is among the earliest of our grasses, and may usually be found in full ear in the beginning of May.

The dried leaves emit an extremely fragrant odour, which, as already noticed, is due to the presence of *cumarine*. The grass is not palatable to animals, and is to be regarded as a weed, unless where the hay is to be sold to those buyers who esteem the hay of special value from the sweet smell due to the presence of the fragrant Sweet Vernal Grass. [J. L.]
[A. N. M'A.]

Anthrax.—Anthrax is a disease of the blood due to a rod-shaped microscopic organism called the *Bacillus anthracis*. It attacks cattle more frequently than other animals; sheep, horses, pigs, dogs, and fowls are liable to anthrax, but not cats.

The mode of infection in animals is chiefly by ingestion. Hay, cake, milk, water, and even oats may be the carriers of infection. Occasionally anthrax is contracted through a wound or scratch in the skin, but this mode of infection is far commoner in human beings than in animals.

Woolpickers get inoculated by anthraxed wool, and this disease, among them, is known as 'woolsorters' disease'.

Symptoms.—The finding of a beast dead, with bloody froth at the mouth, and bleeding at the anus or vagina, is always suspicious.

Other animals in a herd when examined may be found to be dull; rumination and feeding in abeyance; diarrhœa may be present, and blood be discharged from the anus and vagina. Cattle may fall convulsed and then rise again, or rush about in delirium, and fall dead.

In the horse, great swelling of the head, throat, and neck is a prominent symptom, death ensuing in a few hours. Anthrax in the pig, contracted by eating anthraxed flesh, is denoted by swelling of the throat. Dogs, ducks, and fowls may die after eating the flesh or drinking the blood of an anthraxed carcass.

Treatment. — The disease, diagnosed by examining the blood microscopically, must be reported under the Contagious Diseases (Animals) Act. The man for the owner to notify is the nearest chief or superintendent of police.

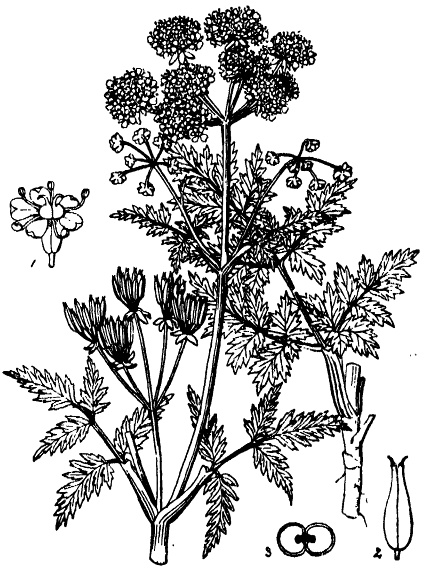
Precautions.—As the discharges are eminently infectious, all the natural openings of the body should be plugged with tow soaked in carbolic acid or creolin. The carcass should be left unopened pending the arrival of a veterinary surgeon. A grave 9 ft. deep should be dug, preferably near the carcass, and the latter should be put into it and covered with lime above and below. The plan of burning the carcass is now frequently practised by up-to-date county councils. If the carcass is moved by the owner to a burial place along a pasture or out of a straw yard, he will be well advised to remove it on an old intact door and not on a gate or hurdle. The object of this is to prevent discharges from contaminating litter or pasture.

The place where an animal has been buried on grazing land should be fenced in, and there should be no running water near it. Earthworms feeding on the carcass are said to reinfect the pasture again and so perpetuate the disease. Pastures notoriously infected should be broken up, and put to any purpose other than grazing. See also ANIMALS, DISEASES OF, and for Symptomatic Anthrax, see BLACK QUARTER. [G. M.]

Anthrenus museorum (Store Beetle).—A small, short, oval beetle, $\frac{1}{12}$ in. long, prettily marked with variegated scales, giving a mottled appearance. There are three irregular transverse pale bands on the wingcases; the legs are short. They feign death, hiding legs and antennæ under their bodies. The larvæ are hairy, the hairs in bundles, with a large pair of tufts at the tail end, which can be expanded. Larval life lasts about a year. Pupation takes place in the ruptured larval skin. They destroy hair, feathers, skins, wool, hides, and other stores of this kind. The beetles occur on the flowers of Umbelliferæ.

The only method of ridding stores of them is either fumigation or 'baking' the stores.
[F. V. T.]

Anthriscus (Beaked Parsley).—Anthriscus is a genus of Umbelliferous plants, and a wild species, Wild Beaked Parsley (*Anthriscus sylvestris*), is the commonest Umbelliferous plant in Britain. This tap-rooted biennial (or sometimes perennial) is a hairy, erect herb, reaching 2 or 3 ft. in height, which bears numerous umbels of



Beaked Parsley (*Anthriscus sylvestris*)

1, Flower. 2, Fruit. 3, Section of Fruit.

white flowers in spring. The fruit is ¼ in. long, smooth and glossy, and narrowed at the apex, so that the beak is not so distinct as in other species. This species grows in hedges, along borders of fields, and on river banks.

A species of Anthriscus, Garden Beaked Parsley or Chervil (*Anthriscus Cerefolium*), is cultivated for use in salads and soups, especially by the French and Dutch. The young plants are gathered when 2 in. high. The curly variety is most esteemed, and many prefer it to parsley.

A poisonous annual species is sometimes found on arable land growing among our crops. This is called Common Beaked Parsley (*Anthriscus vulgaris*), and is easily distinguished by the fruit, which is not smooth, but bears hooked bristles. Certain Dutch soldiers gathered this plant in England in 1745, and mistaking it for the Garden Beaked Parsley, put it into their soup and were poisoned. [A. N. M‘A.]

Anthyllis.—A genus of leguminous plants to which Kidney Vetch belongs. See KIDNEY VETCH.

Antirrhinum (Snapdragon or Calf's Snout).—The name means that the flower is like the nose or snout of an animal, and is derived from the Greek *anti*, instead of or like, and *rhin*, a nose or snout. This genus, reputed poisonous, belongs to the foxglove order, Scrophulariaceæ. A handsome perennial species commonly cultivated in gardens is the Great Snapdragon (*Antirrhinum majus*) (see below). A diminutive annual species, the Lesser Snapdragon (*Antirrhinum Orontium*), is a weed of sandy land, found in cornfields in the south of England and Ireland. This species has the calyx as long as the corolla. In gardens the genus is usually represented by the descendants of that well-defined species, *Antirrhinum majus*, a South European plant which has naturalized itself in certain situations in Great Britain, where it is found growing on old ruins, chalky cliffs, or in rocky places where the detritus contains a proportion of limestone. The typical plant, which has yellowish-brown-coloured flowers, is quite hardy under conditions similar to those suitable for wallflower. Popularly known as the 'Snapdragon', it has become a favourite flower in gardens by reason of its easy culture, hardiness, and diversity in coloration of flower. It likewise forms an excellent example of what can be done towards the improvement of plants for special purposes by a process of careful selection. Like many other plants now indispensable for use or beauty in our gardens, the typical plant soon adapted itself to its changed conditions, and in its exuberant energy soon developed a tendency to variation both in character of flower and habit of growth; a change which the gardener quickly turned to account by selecting and propagating those plants which showed decided signs of departure from the normal type. By persistently following this process of selecting, along with intercrossing, many beautiful varieties were developed. The earlier selections were towards the still popular striped and dark self-coloured varieties to which florists attached fancy varietal names. The trouble involved in keeping these varieties true to name, along with the difficulty in raising stock in sufficient quantity to supply the demand, caused raisers to work towards the production of types that could be raised reasonably pure in character from seed. So successful have the results been that seeds can now be obtained of tall, medium, and dwarf types almost perfect and constant in habit, while the range of colour in each runs from the original yellowish-brown through rich crimsons and yellows, to whites of snow-like purity, with many intermediate blendings of charming shades in indefinite tones, as well as a range of beautifully striped varieties still favoured by many florists.

The plant is of easy cultivation, and though by no means fastidious as to soil, repays good cultivation. On dry, sandy soils it soon gets exhausted, and the flowering period is short, while on generous loams, moderately moist, its development is fuller and more lasting, and few garden plants are more effective and useful, hence the popularity it enjoys.

When raising plants from seed it is advisable to sow as early in the year as possible, and where a greenhouse is not available a frame will be necessary. Fill suitable-sized boxes with a finely prepared mixture of leaf mould and sand, smooth the surface, and as the seeds are small cover them slightly, and water the box with a fine spray. Shade the seed with paper until germination takes place. When the seedlings are strong enough, prick them out three inches apart in boxes, or a frame, using a somewhat rougher mixture of soil. With due attention the plants will be fit to set out in April or May. Should any variety be wanted from cuttings these should be taken off in September or early in October, and made in the orthodox manner, inserting them in sandy soil in boxes or cold frames, keeping them moderately close until root action begins, then airing carefully and regularly as weather conditions demand. [J. WH.]

Antiseptics.—An antiseptic is a substance which prevents putrefaction or decay. Antiseptics and disinfectants are commonly classed together, and the two words are used as almost synonymous. Antiseptic is, however, the term of wider significance. All substances which prevent or destroy the causes of infection are necessarily antiseptics, that is, they are substances which prevent decay. But there are antiseptics which are not disinfectants.

The putrefaction or decay of animal and plant substances is due to the growth in them of low forms of life—bacteria, yeasts, and other minute organisms. These low organisms live upon organic matters, living or dead, and cause chemical changes to take place in them which gradually disintegrate and destroy them. During these changes, foul-smelling gases, such as sulphuretted hydrogen, are often produced, and therefore the decay of animal and vegetable bodies is often accompanied by an evil smell. The processes which are known as fermentations are examples of changes brought about by micro-organisms, known in this case as organized ferments. So also the inflammation of dirty wounds, blood poisoning, and many diseases are due to decay or fermentation processes, brought about by micro-organisms. Antiseptics therefore are used in preventing fermentation, in preventing and combating disease, in preventing inflammation and gangrene of wounds, in preventing bad smells, and for a variety of other purposes. When used to prevent the decay or fermentation of food substances they are commonly called preservatives, and when used in combating disease they are called disinfectants. See arts. on DISINFECTANTS, PRESERVATIVES, PUTREFACTION, FERMENTATION, BACTERIA, &c.

A deodorizer or deodorant is a substance which destroys or prevents offensive odours. Antiseptics are also deodorizers in so far as they prevent evil odours by preventing putrefaction. Some of the best-known deodorizers, such as chloride of lime and carbolic acid, are also antiseptics. But there are also deodorizers which are not antiseptics. These are bodies, such as charcoal, which prevent evil odours by absorbing foul-smelling gases, but which do not prevent the putrefaction by which the gases are produced.

Antiseptic methods have been used since early times for preserving the bodies of men and animals, for preserving food, and for preserving timber. Bodies were embalmed by treating them with various chemicals of an antiseptic nature, and by drying them. Food was preserved by smoking, by salting, and by desiccation. Timber was preserved by charring or by dipping it in tar.

The great development in the use of antiseptics has, however, taken place since the time of Pasteur. It was only after he and his followers had laid the foundations of the science of bacteriology, and mankind had come to recognize that fermentation, decay, and disease are produced by the activity of lower organisms, that the control and prevention of such activity could be undertaken in a scientific manner. The use of antiseptics in surgery has been developed only since the foundations of our knowledge of micro-organisms were laid, but it has quite revolutionized that art. So also the use of antiseptics in preventing and combating disease, in preserving food and other substances which are liable to decay, and in controlling and regulating fermentations, has been developed very largely in quite recent times.

Antiseptics are of various kinds, and of very various degrees of power and efficiency. Physical agents, such as cold and heat, may be used as antiseptics. Cold prevents the activity of lower organisms, though it does not kill them. Hence decay of all kinds can be prevented by freezing or cooling to about freezing-point. This is made use of in the cold storage of food. Immense quantities of food of the most putrescible kinds are carried to this country from distant parts of the world, or are stored in this country for long periods by means of cold stores in which the food is cooled below freezing-point. So also foods which begin to decay very rapidly, such as milk and fish, are preserved for a sufficient length of time to enable them to reach the consumer by mere chilling, without actual freezing.

Up to a certain point decay is more rapid the higher the temperature. The temperature at which changes of fermentation and decay take place most rapidly varies for different kinds of micro-organisms which bring about these changes, but is, generally speaking, about 100° F. As the temperature rises above this, the activity of the organisms begins to fall off, and soon ceases altogether. At a temperature which varies from about 65° C. (150° F.) to boiling-point, according to the kind of organism, all lower organisms are killed. A few of the spores of lower organisms are able to stand boiling temperature for a short time, but even they are destroyed by continued exposure to this temperature. Hence heating to about boiling-point is a most important means of preventing decay, and of disinfecting and preserving substances; and it is made use of for a great variety of purposes.

Micro-organisms require moisture, and therefore if putrescible substances are dried, they will not undergo decay. Hence desiccation has long been used in the preservation of fish, meat, and certain fruits.

The term *antiseptic* is usually applied, however, to chemical substances which destroy lower forms of life, or inhibit to a greater or less extent their activity. A very great variety of such substances are in use. Not only are the antiseptics very various in their chemical composition and nature, but they act upon organisms in many different ways. They have only this in common, that they prevent decay by preventing the activity of the organisms which bring it about. Some of them, like mercuric chloride (corrosive sublimate), are strong poisons to higher as well as lower organisms, while others, like salicylic acid and dilute ozone, have little or no poisonous action on higher organisms. Some of the most widely used are oxidizing agents, and their action is due to their oxidizing power. Examples of these are ozone, chlorine and certain of its compounds, like chloride of lime, permanganates, such as permanganate of potash, and the well-known Condy's fluid. Others, such as sulphurous acid, the sulphides, and sulphur itself, are reducing agents. A great many enter directly into combination with the albuminous or protein matter of the living organisms and form insoluble compounds with it. Examples of these we have in salts of mercury and lead, and in organic compounds like carbolic acid, the other tar acids, and formalin.

The chief substances used as antiseptics are as follows:—

Organic Compounds.—Carbolic acid and other phenols, such as cresylic acids and thymol; salicylic and benzoic acids; formaldehyde and formic acid; chloroform and iodoform; carbon bisulphide; hydrocarbons, like kerosene, naphthalene, and the terpenes.

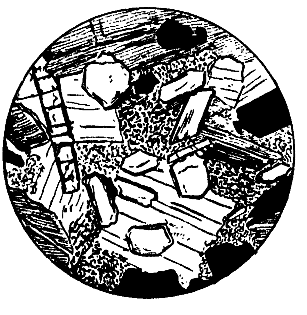
Inorganic Substances.—Ozone and certain ozonized compounds, peroxide of hydrogen and other peroxides; chlorine and its compounds, chloride of lime or bleaching powder, and sodium hypochlorite; sulphur dioxide or sulphurous acid, and the sulphides; boric acid and sodium borates; permanganates of potash and soda; alum; iron salts, such as sulphate of iron; quicklime; mercury compounds, especially corrosive sublimate; zinc compounds, such as zinc chloride. Strong acids, such as nitric and sulphuric acids, and strong alkalis, such as caustic potash and caustic soda, are sometimes used.

New antiseptics are constantly being placed upon the market, but most of these are compounds or mixtures of articles named above. Most of the proprietary articles sold as antiseptics are composed of mixtures or preparations of articles named above. They are generally sold under fanciful trade names, which have little or no reference to their chemical nature.
[J. H.]

Antithesia (Penthina) pruniana (Plum Leaf Tortrix).—A small leaf-rolling moth abundant everywhere. Its front wings have the basal two-thirds brownish black, the apical third white with greyish clouding; hind wings greyish brown. Length of wing expanse $\frac{1}{2}$ to $\frac{3}{4}$ in. The moth appears in June and July. It lays its eggs on the twigs and buds of sloe, plums, and hawthorn, and the larvæ hatch in spring and eat the foliage and blossom.

An allied species, *A. variegata*, which is very similar but rather larger, attacks the apple also. The caterpillars are dull olive-green with fine black spots; head and second segment dark. They pupate amongst the leaves. Like all Tortrices the larvæ have the habit of wriggling backwards when touched. They may be destroyed by spraying with arsenical washes.
[F. V. T.]

Apatite.—The common mineral form in which tricalcium phosphate occurs in nature, united with some calcium fluoride, or, more rarely, with calcium chloride. The composition of apatite may be written as $(CaF, CaCl)\,Ca_4(PO_4)_3$, or as $3\,Ca_3P_2O_8 \cdot Ca\,(Cl, F)_2$. $CaO = 55{\cdot}5$, and $P_2O_5 = 42{\cdot}3$ per cent. Apatite crystallizes in hexagonal prisms, terminated by pyramids and basal planes, but may occur massively in veins. It can be scratched with a knife, but with more difficulty than calcite, and has a specific gravity of 3·2. It is dissolved by hydrochloric or nitric acid, and can easily be tested chemically in cases of doubt. It is colourless to blue, green, yellow, white, or red-brown, only choice or small crystals being transparent. It has a somewhat gummy appearance on fractured surfaces.


Thin section of Dolerite, Portrush, Co. Antrim, with crystals of Apatite, often showing hexagonal forms. Magnified 40 diameters.

Round Ottawa, and in the adjacent parts of Ontario, Canada, crystals of considerable size occur in highly altered limestone and other rocks of the Archæan group, even weighing as much as 400 kilogrammes, and yielding some 90 per cent of calcium phosphate. In the south-east of Norway, notably at Oddegarden, near Langesund, a series of similarly ancient rocks is traversed by veins of apatite, with amphibole, rhombic pyroxene, and ferromagnesian mica. These veins resemble igneous intrusions, in which apatite appears prominently enough to be worked commercially, sometimes forming half the mass. But ordinarily, as a rock constituent, apatite occurs on a widely-diffused but minute scale. Under the influence of natural acids it may ultimately become effective in fertilizing the soil, and it has been asserted that the examination of rock sections with a microscope may serve as a guide in some rocky districts in the choice of farm lands. All granites contain small crystals of apatite, which crystallize out early in the history of the rock, and thus become included in the other minerals. But in rocks with less silica, such as the diorites, these crystals are often far more abundant, appearing in cross section as clear little colourless hexagons shut up in the micas, amphiboles, and other strongly coloured minerals. Analyses of such rocks frequently show ·5 per cent of P_2O_5, and a nepheline basalt of Ciruella, New Mexico, has yielded 1 per cent.

Apatite, like other mineral calcium phosphates, is not used directly as a fertilizer. It has occasionally been used in a very finely divided state, whereby its decomposition was promoted. See arts. GUANO, PHOSPHORITE, and SOMBRERITE.
[G. A. J. C.]

Aphaniptera (Fleas).—A group of Diptera which are quite wingless. The Fleas are partially parasitic on man, animals, and birds. They feed upon blood in their adult stage. The mouth of a flea is adapted to piercing the skin; the hind legs are greatly developed, thus enabling their progress by skipping. They are nocturnal in habits, hiding away in crevices in woodwork, &c., during daytime. The females lay their eggs in dust and dirt, especially in crevices, and the larvæ are in the form of small pearly white maggots with a brown head. They feed upon dry animal matter, and pupate in the places where they feed. Poultry and birds are attacked by the Bird Flea (*Trichopsylla gallinæ*), dogs and cats by *Pulex canis* and *P. felis*, and man by *Pulex irritans* and others.
[F. V. T.]

Aphanite.—A term invented by Häuy, to cover the fine-grained varieties of the rock that he called Diorite. The hornblende and the felspar, usually a lime-soda species, are on so small a scale that they cannot be clearly distinguished by the naked eye. Many 'greenstones' are thus true aphanites. The adjective 'aphanitic' is sometimes used to express a fine-grained structure in other igneous rocks. [G. A. J. C.]

Aphides (Aphididæ, Plantlice, Dolphins, Greenfly).—A family of Hemipterous insects with piercing proboscis, which feed upon the sap of plants. They undergo incomplete metamorphosis, the young being very similar to the adults, but are not winged. They occur in the following forms:—lice or larvæ; wingless females which produce living young; winged females which are viviparous; nymphs or pupæ, which resemble wingless females, but which have wing buds developed at the sides of the thorax, and which give rise to winged viviparous females; egg-laying females, which may be winged or wingless; and winged or wingless males. The latter are frequently devoid of a mouth.

Three main groups occur — 1, Aphidinæ; 2, Schizoneurinæ; and 3, Chermisinæ.

Plantlice are amongst the most troublesome and injurious pests the farmer, gardener, and forester have to contend with; infesting wheat, turnips, beans, peas, hops, cabbages, roses, apple, cherry, currant, and other fruit trees. They are furnished with a short beak, through which pass three fine bristles; these the animal inserts through the cuticle, the central one being tubular, and acting as a siphon. Thus the aphides imbibe the juices from the leaves and stems, sometimes causing distortions, from the vessels being wounded, and the circulation of the sap interrupted. The infested leaves often curl, so as to form cavities or hollow chambers beneath, where the aphides reside; and thus they are provided with habitations, at once protecting them from heat, cold, wet, and the attacks of birds, as seen in the Plum Aphis (*A. pruni*) and the Cherry Aphis (*M. cerasi*).

Owing to the extraordinary fecundity of the aphides, crops suffer severely from their presence in a short space of time. Sometimes one sees a few apterous plantlice upon a bean or currant leaf; at another a single winged female may be detected upon a turnip or hop. Their numbers daily increase, and young lice are quickly deposited. This is a singular feature in the economy of these extraordinary insects; for the fact is, that in the spring the females have the faculty of producing young, and are therefore viviparous; but in the autumn, after the males have appeared, they become oviparous and lay eggs, these being better adapted to withstand the rigour of winter than the unprotected and tender young. These eggs are deposited on and around the buds and on the shoots. Nothing is known of the egg stage in many species. This part of their economy is well deserving the strictest attention of some entomologists.

The spring broods are all females, known as 'mother-queens', and do not require any intercourse of the sexes to render them fertile. They are pregnant at their birth, and if the nit (as it is termed), brought forth by the fly in the spring, be taken and kept entirely excluded from its companions, it will be able to produce young; and if one of these be treated with the same precaution, it will yet be found to retain the same powers of conception: and thus one may proceed for many generations. This will explain their otherwise marvellous multiplication, and the warmer the weather the more rapidly they increase. It has been calculated by an eminent naturalist, that from *one* egg 729,000,000 of plant-lice might be produced in seven generations; admitting forty to be the maximum, and twenty the minimum, the average would be thirty, and the generations from the spring to the autumn amount from sixteen to twenty, or upwards. Réaumur has stated, of another species, that nearly sixty hundred millions may proceed from *one* female in *five* generations! The first females produce about two young daily, for fifteen or twenty days. In ten days the third generation from the egg is capable of bearing young; these comprise both winged and apterous specimens, the former migrating to spread the mischief. Both these sorts are able to bear young in eight days, or even in four; and so they proceed if the temperature prove congenial to their habits. The males are winged and wingless, and do not appear until the autumn. Both sexes are usually provided with a curious apparatus consisting of two tubes called cornicles, through which a sweet liquor exudes; and when it falls upon the surrounding foliage it is termed honey-dew. This honey-dew falls upon the leaves of the plants, and covers them with a sticky layer, upon which the aphides' excrement adheres, and on this a black fungus grows, thus completely covering up the leaf, and preventing proper respiration. The leaves turn yellow, then brown, shrivel up, and die. Some aphides produce 'galls', as seen in the Poplar Gall Aphis (*Pemphigus spirothecæ*, &c.).

Many kinds of Aphididæ live upon two species of plants, migrating from one to another. This is seen in the case of the Hop Aphis (*Phorodon humuli*), which winters on the damson and sloe, and spends the summer on the hops, and in the Apple Stem Aphis (*Aphis fitchii*), which goes to cereals.

Other plantlice have a ground or subterranean and an aerial race, and can migrate from the ground to the stem and foliage, and vice versa (Woolly Aphis and Vine Phylloxera).

The following species of the genus Aphis are the most important in Britain:—

Aphis brassicæ (Cabbage Leaf Plantlouse) is very injurious to the various crops of cabbages, especially sprouts, broccoli, and savoys; but in some seasons the smooth-leaved varieties equally abound with them, and they smother the Swedish turnips. They swarm under the leaves, in some years, from May to the end of November; the females being surrounded by their young broods, and their mates are then wandering about. They first cause pale, irregular swellings on the leaves, in the hollows of which they feed; later, they swarm all over the plants, and collect around the stalks of the sprouts, &c. They are densely covered with meal, secrete much honey-dew, and form a wet, filthy mass over the plants. The male, fig. 1 (1)—(2) the same magnified—is pea-green; the seven-jointed antennæ, head collar, and back of thorax, black; the body is irregularly banded and spotted with pale-black; the cornicles are short, stout, and blackish at the base; nervures of the wings pitch colour, and very distinct; the apical cell large and oval; stigma pale-green; legs black; base of thighs greenish. Female of a yellowish green, and mealy white, spotted with black, fig. 1 (3)—(4) magnified; antennæ shorter, black; two first segments green; third, ochreous; eyes, two large spots on the head and two smaller on the collar, black; body large and heavy; cornicles short and black; legs also black; base of femora greenish.

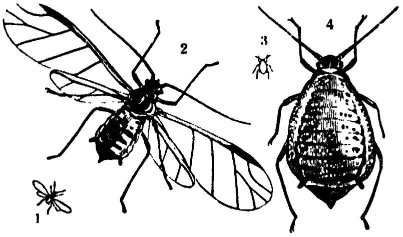


Fig. 1.—Cabbage Leaf Plantlouse (*Aphis brassicæ*

1, 2, Male, nat. size and magnified. 3, 4, Female, nat. size and magnified.

Treatment consists of handpicking the first leaves that show the pale, curled blisters. Later, heavy drenchings with soft soap and quassia, and liver of sulphur.

Aphis pomi, &c. (Apple Aphides).—The most abundant and harmful Apple Aphis is *A. pomi*, which lives permanently on the apple, and which causes the leaves to curl up and eventually turn brown and die. This aphis varies in colour. The young are green or yellow; the apterous females are greenish to grey, with mottled appearance, and covered with grey meal. Winged viviparous females appear in July and August. In autumn wingless males and females occur, and are seen on the under side of the leaves. The oviparous females lay their eggs on the young shoots, which are often covered with the shiny black bodies; they remain on the shoots all the winter, and hatch out in spring.

Another species, *Aphis sorbi* (the Rosy Apple Aphis), also causes the leaves to curl, but more at the sides than with the former, and the curled foliage assumes a rosy-red hue. This species also lives on hawthorn and pear. Like the former, the females are covered with powdery meal.

A third species, *Aphis fitchii*, attacks the blossom, leafage, and shoots. It is green in colour, and leaves the apples in early summer, migrating to corn and grasses, and returns to the apples to deposit eggs, which are placed near a bud. This kind does not cause any leaf-curl.

Treatment consists of early spraying with soft soap and quassia, before the leaves commence to curl, and again a heavy spraying with paraffin emulsion in the autumn, to kill the egg-laying brood and prevent attack for next year. All prunings should be burnt, so as to destroy many eggs.

Aphis pruni (the Leaf-curling Plum Aphis). —A very destructive aphis which curls up the leaves of most prunes, rolling up the sides and sheltering and breeding there, quite protected from the effect of any wash. They leave the plums in summer, but where for we do not know. The species that flies to the hops (*Phorodon humuli, v. malaheb*) acts very similarly, and the two are confused. The aphides are green during most of their apterous stages, but the mother-queen coming from the egg is dull-purple. The eggs are laid in the axils of buds, and hatch in early March into small dull-green lice, which grow into the mother-queen; she produces green living young, which cause the leaf-curl and which reproduce rapidly. Winged generations occur in summer.

Treatment consists of early spraying with dilute paraffin emulsion, to kill the mother-queens when exposed on the shoots before the blossoms burst. Early spring spraying with thick lime and salt wash is also found beneficial.

Aphis rumicis (Bean Plantlouse, Collier, or Black Dolphin).—Soon after the broad beans come into flower, this species makes its appearance upon the succulent tops as a winged female. She soon produces numerous apterous young, and they soon spread to the base of the stalks, when from their intensely black colour they become visible enough. Fig. 2 (1) represents a family so produced. Shortly after this, winged specimens make their appearance, and spread the plague to other beans in all directions. These, fig. 2 (2), the cross-lines at (3) showing the natural size, are of a dull black; the cornicles are rather short; the antennæ are shorter than usual, and brown, as well as the legs, the shanks being ochreous, except at the tips; the nervures of the wings are pale, as well as the stigma. The apterous females are of a bottle-green, and velvety black—fig. 2 (4) magnified—with very globose bodies; the base of the antennæ white; the legs hairy; the first pair of thighs, and the shanks, excepting their tips, are sometimes white; the pupæ are spotted with silvery white. This aphis lives on various species of Dock (Rumex), and migrates to the beans from them. When the beans commence to mature, winged colliers fly back to the docks, and there an ovigerous

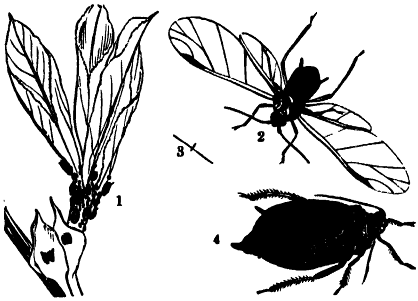


Fig. 2.—Bean Plantlouse (*Aphis rumicis*)

1, Apterous Family at base of stalk. 2, 3, Winged specimen, magnified and nat. size. 4, Female, magnified.

generation is produced, which lay eggs on the docks and remain there all through the winter.

Treatment consists of spraying the beans in field cultivation with soft soap and quassia, topping the attacked and sound beans in gardens, and the rigid exclusion of docks and thistles.

APHIS FLORIS-RAPÆ (Turnip Flower Plantlouse). — Sometimes the flower-stalks of the white turnips swarm with groups of this aphis in July and August, when they no doubt injure the crop of seed very materially. The male, fig. 3 (1) — (2) natural dimensions — is dull pale-green, dusted with white; head, back of trunk, and body, varied with black; cornicles short, barrel-shaped, and ochreous; wings similar to those of *A. brassicæ*; legs ochreous; tips of thighs, shanks, and the feet, brown. Female, fig. 3 (3) magnified — (4) natural size — dull pea-green, powdered with white; eyes black; antennæ short, hairy, and brown, except at the base; spiracles of body, and two rows of dots down the back, black; cornicles short, oval, and black; legs short and hairy; feet black.

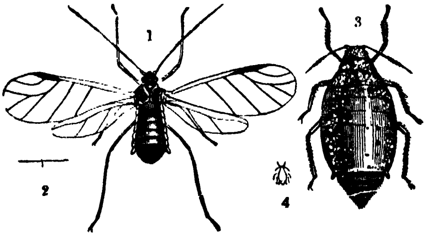


Fig. 3.—Turnip Flower Plantlouse (*Aphis floris-rapæ*)

1, 2, Male, magnified and nat. size. 3, 4, Female, magnified and nat. size.

The principal enemies of plantlice or aphides are the ladybirds, with their larvæ, especially *Adalia bipunctata* and *Coccinella 7-punctata.* The maggots of dipterous flies, called Hover-flies, species of *Syrphus Catabomba*, &c., especially *S. balteata*, *S. ribesii*, and *C. pyrastri*, also feed on aphides. The plantlice-lions, the larvæ of the Golden-eye flies, *Chrysopa perla*, *Hemerobius obscurus*, and other species, live upon aphides. Several kinds of Hymenoptera collect and store up plantlice to feed their young, as *Diodontus minutus* and *tristis*, *Pemphredon lugubris* and *unicolor*, *Psen pallipes* and *Trypoxylon figulus*; whilst *Aphidius avenæ*, *Trionyx rapæ*, *Ephedrus plagiator*, *Asaphes vulgaris*, and others puncture the aphides and lay their eggs in them. On the other hand there are certain species which keep the parasites in check, and amongst these are *Ceraphron carpenteri*, *destructor*, *niger*, and *syrphii*; *Microgaster lineola*, and species of *Bassus*. [J. C.]
[F. V. T.]

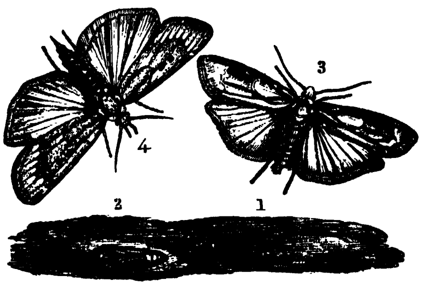
Aphidius avenæ. — Amongst the most serviceable natural agents occupied in keeping noxious insects in check, are the parasitic species. The above-named little ichneumon fly is one of these which deposits its eggs in the apterous female aphides, and thus reduces their numbers to an enormous amount. *A. avenæ* is black and shining; antennæ long, and composed of twenty segments in the male; body brown, the narrowed base rough and ochreous; the margin, and a patch on the back, ochreous; upper wings with a large smoky stigma, and a large central cell, the posterior ones entirely wanting; legs somewhat rusty; all the femora and tibiæ, excepting the first pair, pitchy; feet blackish.

A. rapæ. — A similar shining black species, especially attached to the turnip aphides, but the antennæ are shorter and only fourteen-jointed, with the under side of the base and the mouth ochreous. The body is of a pitchy colour, the base more or less ochreous; stigma of upper wings smoky-ochre, with only a perfect basal cell; legs bright ochreous, variegated with rusty and dark brown. It is 1¼ line long, and the wings expand 2⅓ lines. [J. C.]

Aphodius. — A genus of beetles characteristic of temperate and cold climates, which are extremely useful as scavengers, and may be found during spring, summer, and autumn in dung, and are found flying in swarms where sheep, horses, and cattle occur. They deposit their eggs in dung, and the larvæ feed in it. The maggots are bluish or creamy-white, with brown head and six legs in front, and the body segments divided by transverse folds.

The commonest species is *A. fimetarius*, which has black head and thorax, bright-red elytra and black abdomen, and reaches up to ¼ in. long. They are frequently imported from America on the cattle ships to this country. [F. V. T.]

Aphomia sociella (the Humble Bee Wax-moth) is a moth which creeps into and lays its eggs in humble bees' nests, and it is not improbable that they enter the hives of the honey bee to rob them. The caterpillars they produce feed on the wax, and spin extremely tough grey webs, (1) in fig., in which they live and change to pupæ (2). The moths are of a dirty white, the upper wings have a greenish and rosy tinge, with a line of black dots round the margin, a whitish space near the base, and two black lines near the pinion edge in the male (3); the female has two distinct indented transverse bars, with two black dots on the disc (4); the under wings are smoky. They appear in July and August. The caterpillars are yellowish



Humble Bee Wax-moth (*Aphomia sociella*)

1, Caterpillar's web. 2, Pupa. 3, Moth. 4, Female.

grey, with reddish-brown head, second segment, and brown spots. They are found in August and September. [J. C.]

Aphtha.—Aphtha or thrush is a disease of the mouth in which vesicles or little blebs appear on the tongue and lining membrane of the inside of the lips and cheek. It is associated with a vegetable organism called *Oidium albicans.* It is most frequently seen in young animals, but it may attack animals of any age. It may diminish appetite or cause its loss. There will sooner or later be a dribbling of saliva from the mouth, which will direct the observer's attention to the part affected.

Symptoms.—On opening the mouth or turning the lips up or down, a reddened condition of the membranes will be noticed. Little vesicles or blisters will be seen, and the mouth will be hot and tender. There may be a rise of temperature both local and general.

As a rule, the rate and character of the pulse are not much altered. Mastication and rumination may be lost. In cattle and sheep it is necessary to discriminate between aphtha and foot-and-mouth disease. The vesicles in aphtha are smaller and far more numerous than in foot-and-mouth. In aphtha the dental pad, roof of the mouth, and back of the tongue generally escape, and the feet are not affected.

Treatment.—Gruel, linseed tea, and bran mashes. A pint of linseed oil to a horse, and 1½ pt. to a cow. A mouth wash of alum, ½ oz. in 12 oz. of water, may be used, or a mixture of glycerine and boracic acid may be put on the tongue.

Later on, bicarbonate of soda and gentian may be given two or three times daily in sloppy food. As a tonic, when the animal's mouth shows improvement, quinine and dilute nitro-hydrochloric acid may be given in water twice daily as a draught. [G. M.]

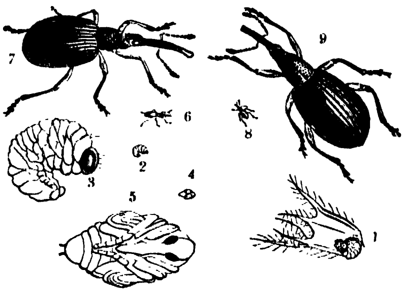
Apiary.—The place or location where bees are kept, with special arrangements for keeping them. Apiaries vary very greatly in size and arrangement, according to the circumstances and views of the bee-master. People who only possess a small garden or grass plot near their houses must make their apiary in some corner; those who have extent and choice of ground should select the most favourable spot in it. A nice dry sheltered position surrounded, but not smothered by trees is the best. It affords protection from strong winds and torrential rains and snowstorms, and gives the bees a chance of a cleansing flight on any sunny day in winter and early spring. If it is on a grass plot, the grass must be kept closely cut, to avoid chilling of the bees in long, wet grass. If it is on a bare piece of ground, it must be kept free of weeds, and better still have always a good coat of hard engine ashes over it. The arrangement of the hives in an apiary admits of various plans. Formerly there were a good many bee-houses or beesheds, in which the different hives were arranged on shelves, sometimes in tiers one above the other, with a separate entrance to each hive leading to the outside. The advantages were supposed to be the perfect protection of the hives from the weather, and the power of manipulating in all kinds of weather. But there are decided disadvantages on the other hand. There is no place for handling bees like the open air in suitable weather; fliers about soon find their way back to their own home; and quietness sets in very quickly after handling. Further, when bees are handled so close to each other in a confined space, an irritation or uproar in one hive is apt to set the heather on fire among the whole stocks. For these and other reasons beehouses or beesheds are not much in vogue now, and are not recommended. Another form much run after for a time was twin or triple beehives, large enough to contain say an entrance at each end and one in the middle. The objections just stated in regard to beehouses and beesheds apply generally to these, with the additional disadvantage that they are heavy, unwieldy, and difficult to move about. The use of single hives on the storifying principle is therefore recommended (see BEES AND BEE KEEPING). These enable each colony to be kept as a distinct home (like the advantage of a selfcontained house over a tenement); they also permit of being easily shifted about to another location, a thing indispensable to successful and profitable bee management. Straw-skeps, Swiss, octagons, Stewarton hives, have all points of advantage under varying conditions of bee keeping; but the hive *par excellence* for pleasure and profit is the bar-frame hive (see HIVES). The form of the arrangement of the hives is a matter of taste, wherein the æsthetic and practical may be combined; but there are certain general principles underlying all good arrangement. Each hive should as far as convenient have an aspect varying from east to south-east and south. They thus catch the early sunshine and warmth, which bring the bees into full activity early in the day. The greater part of the honey is gathered before noon, especially after a nice warm, dewy, summer night. If it is not gathered soon, it is apt to get dissipated, or carried away by other eager gatherers. There is one disadvantage: that if it come bright sunshine in the face of the hives after a snowstorm, the glare of the clear light from the snow deludes the bees, who dash out as if it were midsummer, and perish in hundreds among the snow. This, however, is easily prevented by throwing a few shovelfuls of snow against the entrances early in the morning, or by hanging thick bags over the front of the hives so as effectually to shade the entrance. The disadvantages of having the entrances either to the west or north are quite obvious to any bee keeper. In arranging the rows of hives, care should be taken that each hive is at least 3 ft. apart on each side from its nearest neighbour, and if possible the second and other rows should look over a clear space in front of their entrances, and not over the backs of other hives not far distant, and in front of them. The more freedom for the bees and bee keeper the better. Whatever the position of the hives, they must be made absolutely watertight against winter rains, and the roofs secured against blowing off in violent storms. The latter can be simply secured by passing a piece of coir rope over the roofs and suspending a heavy brick from each end of it. The hive should also be stood firm on its four feet. If the ground is very damp it might be raised a little on solid planks, or by broad bricks below its feet. Take a look around, after a storm, to see all is right; but in the height of summer don't interfere with the bees by walking in front of hives busy at work. Amateurs, in Britain at least, should begin by an apiary of two or three hives, and as they gain experience increase their stocks. To rent a large piece of ground and begin with a score or two of stocks is, for a beginner, simply to court disaster. One word more: in selecting a stance for carried bees or an apiary near heather, always select a bright, breezy hillside, where the sun shines and the breeze plays; low, damp, marshy tracts of heather are valueless for honey production, and full of destructive vermin. [R. M'C.]

Apiculture.—The art of farming bees for profit. See Bees and Bee Keeping.

Apifuge.—A kind of lotion prepared by bee keepers, composed of various strongly odoriferous substances disliked by bees, which when rubbed over the hands and face frequently prevents the bees from stinging. The term is also employed in reference to certain preparations of carbolic, &c., which may be used diluted on a cloth to drive bees from supers and sections. This latter operation is now far better accomplished by the different forms of bee escapes, through which the bees can descend from the supers to the body box with its queen, but cannot return to the supers or sections. A properly-made board, with a bee escape in it, is placed at night between the body box below and the supers above, and in the morning scarce a bee is found above, thus saving a great amount of time and trouble, and not harassing the bees. See Honey, Removing and Marketing of. [R. M'C.]

Apion apricans (Purple Clover Weevil) belongs to a genus of weevils which is distinguished from most others by having a long arched proboscis prefixed to an oval body, giving the insect the form of a long-stalked pear. This and the two following species injure the crops of clover when in flower, rendering them brown and prematurely ripe in appearance. If the clover flowers in the field be shaken over a cloth, thousands of these weevils will fall upon it, often in pairs. The females reside amongst the florets to deposit their eggs, which hatch there, and the young maggot feeds upon the seeds as shown in accompanying fig. (1) a little magnified. It is a fat, fleshy larva, (2)—(3) magnified—of a whitish colour, with a brown head, and sometimes three or four are concealed curled up in one head of clover, particularly at the end of August and beginning of September. In the same situation it is transformed into a white pupa with dark eyes, (4)—(5) magnified—and a fresh brood of weevils is produced by the autumn. The beetles are frequently so abundant at the close of summer, that upwards of a hundred may be seen on one leaf, feeding on the foliage, and riddling it like a sieve, sometimes to a great extent. The second species mentioned here is probably only a variety of the first.

A. apricans, (6) in fig.—(7) magnified—is pear-shaped, shining bluish-black; the head and trunk are punctured, the former is channelled between the eyes, and the latter has a furrow down the hinder part; on the wing-cases are sixteen punctured furrows, and beneath them are folded a pair of ample wings; it has two eyes near the base of the head; and the pair of eleven-jointed antennæ are placed on each side of the rostrum and near the middle; they terminate in a little club; the first segment is the largest, and is bright ochreous, and sometimes the second and third also; the six legs are of the same colour, the tips of the thighs being black as well as the shanks (excepting the first pair) and all the feet. The male is rather smaller than the female, fig. (6), with a shorter and stouter proboscis This species inhabits the Purple Clover, *Trifolium pratense*. It is infested by two minute parasitic flies. It appears first in the spring.



1, Maggot of Purple Clover Weevil, feeding upon seed, a little magnified. 2, 3, Larva, nat. size and magnified. 4, 5, Pupa, nat. size and magnified. 6, 7, *Apion apricans*, nat. size and magnified. 8, 9, *Apion assimile*, nat. size and magnified.

A. assimile, (8) in fig.—(9) magnified—is very like *A. apricans*, but it is smaller, and distinguished by the base of the antennæ and the fore shanks being of a duller colour. It is generally most attached to the Sulphur Trefoil, *Trifolium ochroleucum*, yet it accompanies the other species on the Purple Clover in some seasons.

A. dichroum—called *flavipes* by Curtis—(Yellow-legged or Dutch Clover Weevil) is also similar to the foregoing species. It is more slender in form, and the legs are entirely bright ochreous, excepting the black feet and tips of the shanks; the two first segments of the antennæ are bright ochreous, and the trunk is not so coarsely punctured.

The Dutch or White Clover, *Trifolium repens*, is especially liable to the depredations of this species, which lays its eggs amongst the flowers. With these maggots are found minute orange-coloured larvæ in great abundance, which are the offspring of a small gnat allied to the wheat-midge. This is *Cecidomyia trifolii.*

A. pomonæ (Tare or Vetch Weevil) is a larger species than the foregoing, being two lines long. It is black, and clothed with short white hairs; the head is coarsely punctured; the thorax is tinged with blue, and thickly punctured, with a channel behind; the wingcases are blue, with eighteen sharp furrows, covering ample wings; the rostrum is shining, bottle-shaped and slender at the tip in the male; stouter, bent, and conical in the female.

These weevils are abundant from the spring to the autumn, and probably lay their eggs in the flowers of the common tare, *Vicia sativa*, for the pods are often distorted, and in July whitish maggots may be found in them, feeding upon the seeds, and causing a light crop; they change to yellowish pupæ, in cells formed amongst the seeds, and the weevils seem to be principally hatched from them in August. [J. C.]
[F. V. T.]

Apis mellifica. See Bees.

Apoderus coryli (Leaf-box Beetle).—A small weevil ¼ to ⅓ in. long, bright-red, with head, antennæ, and median spot on prothorax black. The female cuts the leaves of various broad-leaved trees in May by a transverse incision towards the base and reaching the midrib. The terminal part is then rolled into a cylindrical roll, in which is laid a single yellow egg. The maggot feeds in the roll, which becomes detached and falls to the ground, in which the larva pupates. It especially attacks hazel, oak, alder, and hornbeam, frequenting undergrowth and nurseries.

The rolls should be collected in nurseries, and the beetles jarred off on to tarred cloths. [F. V. T.]

Apoplexy.—Apoplexy is one of the most appalling modes of sudden death. Fortunately in the domesticated animals it is not very common. Perhaps the pig is the most subject to it. It is essentially an affection of the brain. It may arise in animals from degeneration and rupture of one of the bloodvessels of the brain, or from arrest of cerebral circulation by a plug derived from the lining membrane of a diseased bloodvessel lodging in one of the arteries of the brain. Hence it may be brought about where there is a diseased valve of the heart. The male is more subject to apoplexy than the female.

Plethoric fat animals suffer from it more than thin animals. Fat dogs straining at a chain in a sunburnt backyard occasionally suffer from it. Sunstroke is a form of apoplexy. It is generally a fatal disease, and always serious.

Symptoms.—Sudden falling, and loss of consciousness. Breathing noisy and difficult, and frequently through the mouth. The eyes may move about convulsively, or they may be wide open and staring. Urine and dung not passed. The limbs may be moved spasmodically and the head knocked about. This is one of the few diseases of animals in which the pulse beats and temperature may be below the normal.

Treatment.—The patient, if falling on the highway, should be immediately got into a field, shed, or stable if handy. A gate taken from its hinges will make an improvised sledge to remove the patient off the road. If taken to a field, the sufferer should be covered with straw in winter, and packed up with sacks of straw to prevent damaging the eyes and head. As soon as possible an active purgative should be given.

Perhaps few things are better for this complaint than croton oil: 20 drops in 1 pt. of linseed oil to the horse, and 30 drops in linseed oil to a cow, giving the draught slowly; or a hypodermic injection of eserine may be given. Apply ice or iced water to the head if procurable. Well rub the legs with wisps of straw, and if possible apply warm bandages. Bleeding prevents an attack when threatening.

Pigs should be slaughtered and bled. Dogs should have purgative pills or 2 to 4 tablespoonfuls of castor oil given them; cold to the head and warmth to the feet. [G. M.]

Apoplexy, Parturient. See Milk Fever.

Appenzell Goat.—A white variety of the Toggenburg (which see). Large herds are met with on the slopes of the Sentis mountain, dividing the Canton St. Gall from Appenzell. [H. S. H. P.]

Appetite.—The word in connection with animals is often restricted to a desire for food, but of course applies to other desires, as the sexual, the wish for muscular exertion, or other natural craving; and any loss of normal appetite in the animals of the farm may indicate illness, sterility, or defective temperament. Without regular returning appetite for food, no animal can thrive, no energy be stored for muscular exertion in the working horse or ox, and no accumulation of fat in the animal destined for the butcher. For the production of an abundant supply of milk, good appetite is the first essential, for without it no sufficient quantity of food will be assimilated or lacteal fluid secreted. Practical horsemen and stock-keepers are therefore agreed in the desire to obtain what are known as 'good doers' possessed of appetite which does not fail, and have learned by outward signs to recognize such as are likely to enjoy good appetites and corresponding powers of digestion.

From the economic point of view it is, then, of first-rate importance that appetite should be considered in the management of live stock. From the hygienic and veterinary aspect it is matter for watchfulness and careful consideration. The stock-raiser may select the most suitable ration to produce a given result, but if the animal has no appetite for it, or from health reasons cannot take enough of it, failure will result. In this connection it may be remarked that feeding of live stock is an art which seems to be easily acquired by some men and impossible of attainment by others. Stockmen with this gift learn to know the taste and measure the appetite of each animal under their care, and will induce appetite in one by offering food only in small quantities, and in another by giving attention to a rival in the next stall. Appetite is promoted by the use of salt, by many cattle spices and compounds, for which there is a great sale; but such artificial stimulants must not be persisted in or they fail of their effect, or else become a necessity, like sauces to persons habituated to their use.

Failure of appetite should always be regarded as a matter of importance and needing investigation, the more so if it is sudden and in complete abeyance. Only to the expert are the symptoms of many diseases apparent, but inappetence is a warning to all, and every man in charge of live stock should have instructions to report if an animal misses a single meal. Abstinence may be all that is needed to restore to health, but many fatal maladies show no other sign at first than that of dulness and loss of appetite; and it is the universal experience of veterinary practitioners that sufficient importance is not attached to failure of appetite in animals, and that much valuable time is lost in treatment, or infectious cases are allowed to remain in contact, through the attendant's ignorance of the importance of the subject.

[H. L.]

Apples.—The apple takes first rank amongst the more important hardy fruits cultivated in the United Kingdom, and owes its high position to many valuable qualities. It may be successfully grown in any part of the British Islands, and in a great variety of soils and situations, though its best qualities are only developed under special circumstances of soil and climate. All the apples known are the progeny of *Pyrus Malus*, which is wild in many parts of Europe and Asia. It has been used as food and cultivated by man for upwards of 4000 years. The greater number of the varieties now in cultivation have, however, been bred within the last century or so, new varieties being added yearly. The oldest apple in cultivation is a variety called The Lady, which originated in Britain early in the 17th century. Other very old sorts are Cat's Head, Golden Pippin, Joannetting, and the Summer Pearmain. Improved varieties are obtained by means of seeds, and whilst some are the result of careful crossing, a large number are of chance origin. Among the latter are such high-class sorts as Ribston Pippin, Blenheim Pippin, Dumelow's Seedling, and Devonshire Quarrenden; Claygate Pearmain was found in a hedge, Keswick Codling on a rubbish heap, and Cornish Gilliflower in a cottager's garden. We cannot, however, rely upon seeds for the perpetuation of any particular variety; thus seeds of Ribston Pippin would not yield one in ten thousand of equal quality to the parent. From this it will be seen that the breeding of first-quality apples is slow and uncertain. The aim of the breeder should be to obtain varieties that would flower later than the majority now do, and thus avoid the injury caused by late spring frosts. Late-keeping qualities are also valuable, and of course richness of flavour is a very desirable quality to be aimed at.

Practically all the apples that are grown are grafted or budded upon certain kinds known to be useful as stocks. Seedlings of the common crab, known as the Free Stock, are used for apples intended to grow into large orchard trees, whilst the stock known as the Paradise is preferred when small bush trees are desired, this stock having a dwarfing influence upon the tree. A definite rule cannot, however, be laid down in regard to stocks; the depth and quality of the soil must also be taken into account. Generally it is advisable to consult local growers as to not only the kind of stock, but the selection of varieties best adapted for any particular district. Where the site for a garden has been chosen with judgment there will be no difficulty in the selection of varieties of apple that will give satisfaction. The apple thrives best in an open situation where it will receive the maximum amount of sunshine and protection from cold winds. The protection is particularly necessary in districts where cold winds and frosts prevail during the flowering season. The better the soil the larger the crop and the better the quality of the fruit will be, and even where the soil is good it is necessary to manure freely, especially when the trees are large and yield freely. It is said that 5 bus. of apples remove 11 lb. of nitrogen, 1 lb. of phosphoric acid, and 16 lb. of potash from the soil, and this is at least doubled by the food extracted by leaf growth. From this it will be seen that the richest soil would be gradually exhausted if annual manuring was not resorted to. For orchard trees where grass is allowed to grow, it is necessary to keep the soil immediately beneath the trees open and uncovered by vegetation of any kind. Very large long-established trees are not much influenced, but for young trees it is certainly requisite to make this provision.

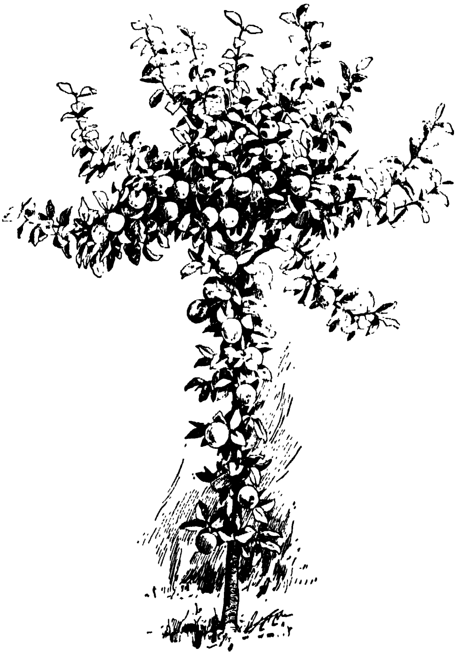


Fig. 1.– Standard Apple

The preparation of the soil in which apples are to be planted consists in draining, unless the subsoil is such as to render artificial drainage unnecessary; trenching, especially in small areas, and even for orchards of large size, may be desirable, unless the soil is known to be in good condition for a reasonable depth. Bastard trenching is best for orchards; that is, two full spits are turned over, but the lower spit is kept below. On wet or cold soils it would be advisable to add soil of a lighter quality, after trenching has been performed. Even a barrowful of good soil put into a hole made for each young tree would be better as an aid to a healthy start. Where the soil is light and not naturally rich enough, it should be well manured, a healthy, vigorous growth being very desirable for the first year or two, and this manure should be worked in at the time of trenching, about 1 ft. below the surface. Well-rotted farmyard manure is, on the whole, the best kind to use for apples, and indeed for fruit trees generally.

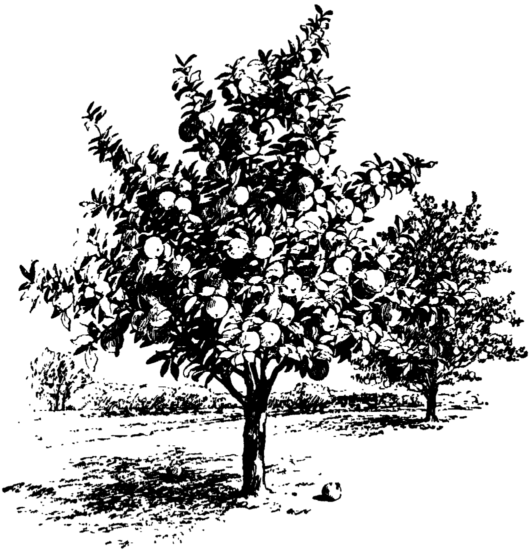


Fig. 2.—Dwarf Tree on Paradise Stock

From 12 to 20 tons per acre is roughly about the quantity of manure that should be dug in at the time of trenching.

The arrangement of the orchard in which apples are to be the main feature requires consideration. There are two plans, the square and the quincunx, the square system being to arrange the trees 30 ft. apart each way, so that each tree stands at the corner of a square. For permanent planting this is to be recommended, as it is easily worked and kept in order. The quincunx arrangement is to set the trees so that they are equidistant in the lines and the rows are the same distance apart, but each alternate line is commenced opposite the space between the two trees in the adjoining lines, so that they would stand in triangular form. Standard apples can be planted at any distance from 20 to 30 ft. apart, the small growers having ample space at 20 ft., and the strongest sufficient at 30 ft. Should it be intended to grow bush fruits, such as currants and gooseberries, or vegetables, between the rows of apple trees, then the square system with the trees 30 ft. apart is recommended. If the ground has not been broken before planting is done, then each young tree should be set in a space 6 ft. in diameter, in which the soil has been properly prepared, and after the tree is planted, this space should be kept clear of grass and weeds at all times.

When the trees have made free growth it may be necessary to enlarge this cultivated area round each one, although generally it is not worth while. Undoubtedly grass growing over the roots of trees checks their growth, but this check may be an advantage on soil which favours vigorous growth, as it will induce the formation of flowering shoots. Where the whole of the ground is cultivated or cropped, this factor does not come in, and root pruning, to which reference will be made presently, must be resorted to if a check in growth is desired. Market growers utilize every foot of space where apples are grown, and with a little care this surface cropping becomes a help, rather than a hindrance, to the production of full crops of fruit. It is probable that the rough root pruning performed when digging and planting take place tends to prevent luxuriant growth. At the same time it is necessary to have an eye to the proper balance of matters, and to cease to grow vegetables if this can only be done at the expense of apples. Some growers advise that a space of 5 ft. from the rows of apple trees should always be kept clear of crops.

The selection of young trees for planting is a matter of importance, and should only be entrusted to experts. There are nurserymen who may be relied upon to supply the right kinds in the shape of well-grown, healthy young trees, and it is certainly advisable to leave the selection to them, rather than to attempt it with the assistance of books. For orchard purposes (fig. 1), standards with stems 5 to 6 ft. high are the best form to plant; and although it may take eight or ten years before satisfactory crops will be yielded, for permanent plantations such standards worked on the crab or free stock are ultimately most profitable. There are orchards of such which have been known to yield excellent crops for over fifty years, and the trees are full of vigour still. Where early returns are desired, dwarf trees on Paradise stocks are by far the most useful (fig. 2), especially in a case of short tenancy. Such trees will produce fine fruits in the second or third year, and under average conditions will continue to crop well for twenty years more. If small trees on Paradise are decided upon, and planted 12 ft. apart, or even less, the produce, under skilful management, may be as much as 500 bushels per acre. The best time to plant apples is in the early autumn as soon as the leaves have fallen, say in October, and before the soil has lost the heat accumulated during the summer; the trees then have time to recover from the check, and even make some roots by the following spring. At the same time, planting may be safely performed until growing time in spring. We have planted them in April successfully, but the operation then required special care, and the treatment for some weeks afterwards entailed extra labour. At the time of planting, the trees will probably require the support of stakes. In the case of standards they certainly will. It is poor economy to provide cheap stakes for the purpose; the most suitable kinds may be obtained from dealers, but if they can be made on the place they should be formed of good wood of sufficient diameter to afford the requisite support, say 2½ in. They should be pointed, so that they can be driven into the ground with a mallet, and if possible the bases dipped in tar or creosote before they are used. Stout tar twine is the best tie. Even such an operation as the staking and tying of a young tree may be so badly performed by a thoughtless workman as to result in its permanent injury. For large plantations it is a good plan to space out the ground, prepare the holes, and drive in the stake before the trees are ordered; the operation of actual planting is then quite a simple one. The roots should not be buried more than 6 in. from the surface, and they should be spread out evenly and horizontally before they are covered, and the soil made firm by treading. It may be necessary to go over the plantation several times in the first year to tread the soil about newly-planted trees. If the soil is heavy or wet at the time of planting, less treading will be needed than when the soil is light. Injury may be done by carelessness in this respect.

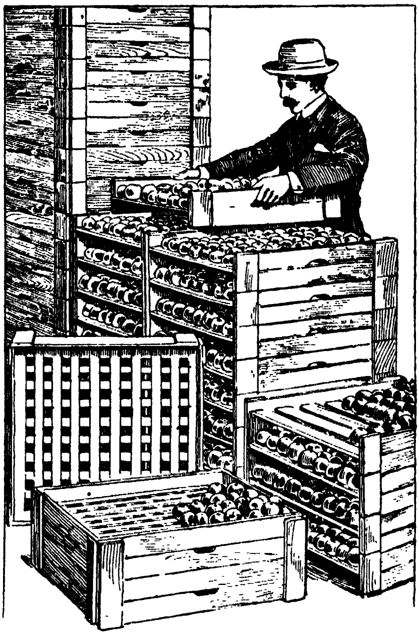


Fig. 4.—Orr's Storing Trays for Apples, &c.

After planting comes pruning. For orchard trees less pruning is advisable than for those in small gardens, but all young trees require to be gone over at least once a year so as to lay a proper foundation for a well-balanced, well-furnished tree. The stems of standards must be kept clear of shoots, and much depends on the main branches being equally started. As a rule the uppermost shoots will grow too vigorously, and therefore must be shortened back. Where the time can be spared, summer pruning, that is, pinching out the point of the young green shoot, may be resorted to with advantage. In any case, the winter pruning should be to shorten each of the main shoots to within 9 in. of its base, and the

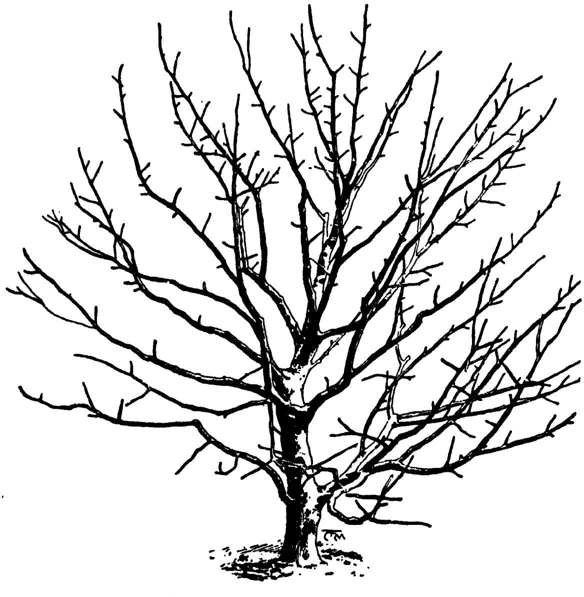


Fig. 3.—A well-developed six-year-old Pyramid Apple after pruning

removal entirely of superfluous shoots. A young tree with a thin open head will make a better specimen than one that is allowed to grow close-headed. For dwarf pyramids and bushes the treatment of young trees should be that recommended for standards, but they will require more severe pruning as they grow larger, that is, in winter the main shoots should be shortened to a length of about 6 in., and the laterals to quite short spurs. The operation of pruning is, however, one that needs care. It is best left alone if the principles are not thoroughly understood, for certainly an unpruned apple tree will be more successful than one that has been pruned badly. Pruning, like surgery, can only be a success when it is done scientifically.

Root pruning is for the purpose of checking excessive vigour and promoting fruitfulness. It is performed during winter by opening a trench at a distance of 3 ft. or more from the stem, cutting off the roots that are exposed, and driving under the ball, at a distance of, say, 1 yd. from the surface, a turf-slicer to cut through any strong roots that grow perpendicularly downwards. For trees less than ten years old, transplanting serves the same purpose, and is, on the whole, to be preferred; but for old trees this would be impracticable.

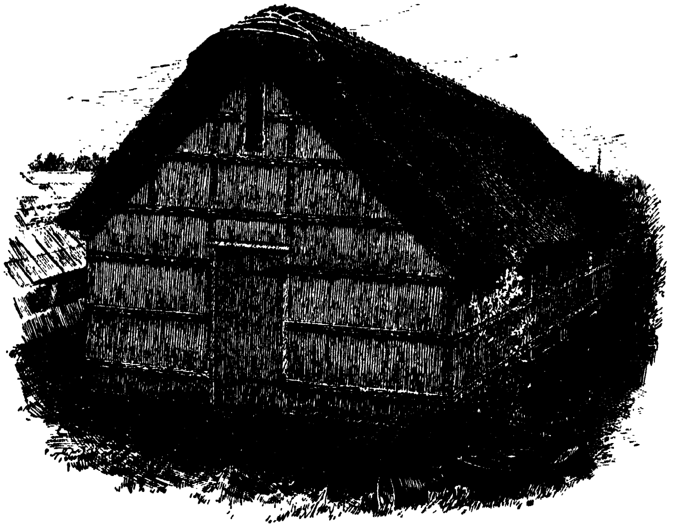


Fig. 5.—Bunyard's Fruit Room (exterior)

The gathering and storing of apples require a great deal more care than is usually expended upon them. The fruit should be handled as carefully as if it were eggs. The gathering baskets or trays should be lined with some soft substance, and the fruit laid in single layers rather than piled up in heaps. An excellent form of tray for the purpose is illustrated in fig. 4, where the apples as they are gathered are at once placed in layers in a drawer-like arrangement, and are easily stacked one above the other. The most essential points in storing are an even and low temperature with darkness, and no greater circulation of air than is necessary to prevent excessive moisture. To ensure these conditions the storeroom should be in a dry, airy situation. A cheap and effective fruit room is here illustrated (figs. 5 and 6); it is 30 ft. long, 12 ft. wide, and will hold 300 bus. of fruits, its cost being about £30. It is built with wooden posts, and thatch 18 in. thick on the roof and 6 in. at the side. There is a ventilator at each end, which is covered with wire-netting to keep out vermin. The floor is made of cement mixed with the soil. The fruit should be dried when stored, and afterwards examined periodically. The floor should always be damp. In such a store, apples may be kept until May or June.

The number of named varieties of apples known is probably over 2000, but this number might with advantage be reduced to 200, the differences between many of them being very slight. Moreover, there are not 200 named varieties that may be called first-class. The best descriptive list of apples is in Hogg's Fruit Manual, to which the reader is referred for particulars of any given variety.

The following select list includes only those apples which have proved satisfactory and are of recognized value:—

Adam's Pearmain.—Dessert. Nov.–Feb. A good keeper. Fruit medium, conical, yellowish with russet spots and red streaks; rich flavour.

Allington Pippin.—Dessert. Nov.–Feb. Resembles Cox's Orange Pippin, but larger and softer in flesh. Flavour varying; best on warm soils.

Allen's Everlasting.—Dessert. March-May. Good keeper if left on the tree as long as possible. Fruit medium, yellow with red streaks, juicy and aromatic.

Annie Elizabeth.—Culinary. Dec.-April. Good keeper. An excellent market apple. Fruit large, round and ribbed, yellow with a red tinge.

Beauty of Bath.—Dessert. July-Aug. An excellent early variety, the best for market. Fruit medium, round, yellow and red.

Beauty of Kent.—Culinary. Nov.-Jan. Fruit large, round, yellow, green, and red, acid and well flavoured.

Bismarck.—Culinary. Oct.-Feb. Fruit large, round, dark crimson, acid and pleasant flavoured.

Blenheim Orange.—Nov.-Feb. A first-class all-round apple. Fruit large, round, with a very open eye, green and yellow. Flesh soft and richly flavoured when ripe.

Bramley's Seedling.—Culinary. Dec.-May. Fruit large, round, flattened at top, green tinged with red; acid; first-rate cooker.

Claygate Pearmain.—Dessert. Jan.-Feb. First-class prolific sort. Fruit medium, conical, green and red, flavour rich and sweet.

Cornish Aromatic.—Dessert. Oct.-Jan. First-class apple; medium to large, round; yellow, russet, and red; rich flavour.

Cornish Gilliflower.—Dessert. Jan.-May. A good apple in the south. Fruit medium, angular, dull green and red. Very sweet and aromatic.

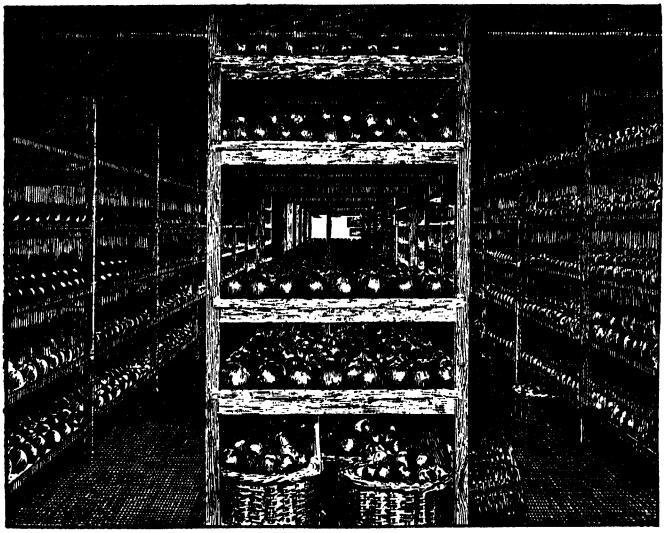


Fig. 6.—Bunyard's Fruit Room (interior)

Cox's Orange Pippin.—Dessert. Nov.-Feb. The best apple. A certain cropper, and excellent keeper. Fruit medium, round, yellow and bright red, very juicy, sweet and rich in flavour.

Cox's Pomona.—Dessert and culinary. Oct.-Nov. A free bearer. Fruit large, round, angular, yellow and red. Flavour acid and agreeable.

Devonshire Quarrenden.—Dessert. August. An excellent early sort. Fruit medium, roundish, dark-red, juicy and aromatic.

Duchess of Oldenburg.—Culinary. Aug.-Sept. A first-rate early. A free and certain cropper. Fruit large, round, ribbed, green, yellow, and red; acid.

Dumelow's Seedling.—Culinary. Nov.-Mar. Fruit large, round, slightly depressed, yellow tinted red. Acid and pleasant in flavour.

Early Rivers.—Culinary. Aug.-Sept. Very free and prolific. Fruit medium, round, yellow. Brisk flavour.

Ecklinville.—Culinary. Sept.-Nov. A most useful apple. Fruit large, round, depressed, green and yellow. Flesh soft when ripe.

Fearn's Pippin.—Dessert. Jan.-Mar. A good cropper and keeper. Fruit medium, yellow and russet red; flavour brisk, improving with keeping.

Gascoyne's Scarlet.—Dessert and culinary. Nov.-Feb. A good market apple; very prolific. Fruit large, angular, yellow and red; flavour acid and agreeable.

Golden Noble.—Culinary. Oct.-Dec. A serviceable garden apple. Fruit large, round, and even, yellow, firm fleshed, acid.

Golden Pippin.—Dessert. Nov.-April. An old favourite. Fruit small, round, yellow with russet spots; rich and sweet.

Golden Spire.—Dessert and culinary. Oct.-Dec. The poor man's apple. A free and certain bearer. Fruit large, conical, deep yellow; flavour acid and agreeable.

Gravenstein.—Dessert and culinary. Oct.-

Dec. A favourite in Germany. Fruit large, round, angular, yellow with red spots; very juicy and aromatic.

Grenadier. — Culinary. Sept. - Oct. Good market apple. Fruit large, round, ribbed, deep yellow; acid and rich in flavour.

Hawthornden.—Culinary. Oct.-Dec. An excellent apple. Fruit large, round, greenish yellow with a red tint; slightly acid and of good flavour.

Irish Peach.—Dessert. August. One of the best earlies. Fruit medium, round, yellow and red; richly flavoured.

Keddleston Pippin.—Dessert. Dec.-Mar. A useful little apple; round, yellow, and russet. Flavour rich and sweet.

Keswick Codling. — Culinary. Aug. - Sept. An old favourite. Fruit medium, conical, ribbed, yellow green.

King of the Pippins.—Dessert. Oct.-Jan. A most popular apple. Fruit medium, conical, bright yellow and red; quality best in November.

King of Tompkins' County. — Dessert and culinary. Dec.-Feb. Of American origin; has become popular in England. Fruit large, round, depressed, yellow streaked red; flavour sweet and rich.

Lane's Prince Albert.— Dessert and culinary. Nov.-Mar. A first-rate market apple. Fruit large, round, smooth, yellow-green with red tint; acid and pleasant.

Langley Pippin.—Dessert. Sept. Free and prolific. Fruit medium, conical, yellow streaked with red. Flavour aromatic and agreeable.

Lord Grosvenor.—Culinary. Aug.-Sept. An excellent variety; free and certain. Fruit large, conical, yellow; juicy and acid.

Lord Suffield.—Culinary. Aug.-Sept. An excellent apple on warm soils. Fruit large, conical, yellow; acid and well flavoured.

Margil.—Dessert. Oct.-Jan. Fruit small, conical, yellow and red; very juicy and aromatic.

Mr. Gladstone.—Dessert. July-Aug. A useful early sort. Fruit medium, yellow with red streaks; juicy and agreeable. Must be eaten soon as gathered.

Newton Wonder.—Culinary. Nov.-May. An excellent late sort. Fruit large, round, even, yellow and red; acid and agreeable.

Newtown Pippin.—Dessert. Dec.-April. An old American variety. Fruit medium, round, green; very juicy and rich.

Norfolk Beefing.—Culinary. Jan.-May. An excellent keeper. Fruit large, round, depressed, yellow and dark red; acid and well flavoured.

Peasgood's Nonsuch. —Culinary. Nov.-Dec. One of the largest and handsomest. Yellow with red streaks; acid and juicy.

Potts' Seedling.—Culinary. Aug.-Oct. An excellent market sort. Fruit large, round, green, changing to yellow. A good cooker.

Ribston Pippin. — Dessert. Dec. A grand apple, but somewhat uncertain. Fruit medium, round, angular, yellow and red; flavour rich, sweet, and perfect.

Royal Russet.—Culinary. Nov.-May. One of the best. Keeps well. Fruit large, round, yellow and russet; juicy and very sweet.

Scarlet Pearmain.—Dessert. Oct.-Jan. Very hardy and prolific. Fruit medium, conical, even, yellow with red streaks; flavour sweet and agreeable.

Stirling Castle.—Culinary. Oct.-Dec. One of the best market apples. Fruit large, round, even, yellow with slight red tint; juicy and acid.

Sturmer Pippin.—Dessert. Feb.-June. The best late apple. Fruit medium, round, yellow and russet red; flavour rich and pleasing.

Warner's King. — Culinary. Nov.-Dec. A first-rate market apple. Fruit large, round, slightly angular, yellowish green; acid and of good flavour.

Wealthy.—Dessert and culinary. Nov.-Dec. Of American origin. Fruit medium, round, even, yellow streaked with red; flavour rich and peculiar.

Winter Greening.—Culinary. Nov.-May. One of the best keepers. Fruit medium, round, deep green; very firm and acid.

Worcester Pearmain.—Dessert. Sept.-Oct. A good market sort, very prolific and hardy. Fruit medium, conical, yellow tinted with red; sweet and rich, especially in September.

Twelve of the best apples:—Beauty of Bath, Bramley's Seedling, Cox's Orange Pippin, Devonshire Quarrenden, Fearne's Pippin, King of the Pippins, Lane's Prince Albert, Lord Grosvenor, Newton Wonder, Potts' Seedling, Stirling Castle, Worcester Pearmain. [W. W.]

Apple.—Parasitic Fungi.—The orchard harbours so many parasitic fungi that it will only be possible to group together some of the more destructive and common forms, to describe them briefly, and to suggest the general methods for prevention and treatment.

WOOD ROT AND CANKER.—The pruning necessary in an orchard leaves wounds through which certain fungi gain admission and do much damage. Decay of the wood can frequently be traced extending from the stump of some branch sawn or broken off, so leaving a place where weather and organisms can attack the wood. Through much smaller wounds parasitic fungi belonging to the Polypores may gain admission and carry on unseen their work of heart rot. (See art. FUNGI—BASIDIOMYCETES.)

The canker of apple trees differs from heart rot in that it is not concealed inside the wood, but causes external wounds. The most frequent cause of canker on the apple and other trees is *Nectria ditissima.* The most conspicuous stage of this and several closely-related species of fungi is frequently to be seen on dead branches and stems of many different trees, in the form of tiny bright-red buttons studded over the bark. The fungus can live on dead bark and wood as a saprophyte, but if given the opportunity of reaching the living tissues through a wound, the spores (conidia) give rise to a parasitic mycelium. A healthy wound is naturally closed by an overgrowth of new bark and wood, but if infected with *Nectria* it refuses to heal, the wood remains exposed and dead, while the bark round it becomes thickened and wrinkled, and as a rule fails to cover the wound over (fig. 1). As the wood is killed, the branch is ringed and ultimately dies off. A second stage of the fungus

APPLES [illegible]

harbours in the bark and dead wood in the form of dull-red pustules, from which spores (ascospores) are liberated; the discovery of this stage proved *Nectria* to be an Ascomycete. (See Fungi.) Since dead wood and branches are liable to harbour canker and wood rot, they should be removed and destroyed. Cankered branches should be removed by cutting off below the canker. The immediate application of tar to all cuts made in pruning thick branches prevents germination of *Nectria* and other spores. Where amputation of a large branch would mean serious damage to a tree, it is sometimes possible to scrape away the diseased wood and bark and to apply tar. The application of fungicides and stem-washes will check canker and wood rot.

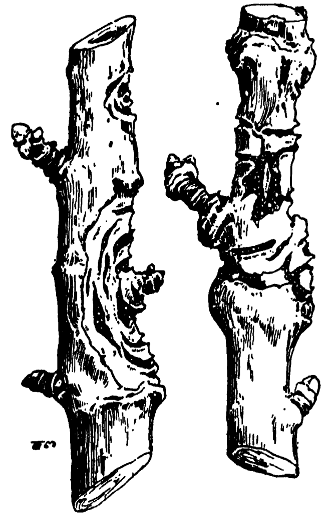


Fig. 1.—Apple Tree Canker (*Nectria ditissima*)

Branches of an Apple Tree showing the bark destroyed by the fungus. The little white points in the cracks on the diseased parts are the fruits of the fungus, which are of a bright-red colour. (Natural size.)

Bark Scab on Twigs and Branches.—Discoloured spots or small scabs may occur on the young bark, and lead to formation of badly-matured wood. These may be caused by the Apple Scab fungus (*Fusicladium*) so common on the foliage, or by other fungi, such as ***Eutypella prunastri*** (description and figures in Board of Agriculture Leaflet No. 87). The disease is checked by attention to pruning wounds, and by winter washes and the fungicides used for spraying foliage.

Moulds or Discolorations on Leaf and Fruit.—Powdery Mildew (*Sphærotheca mali*, *Podosphæra*, and other species of Erysipheæ) is easily recognized as a white or greyish mildew which appears on the young leaves and twigs, extending sometimes to flowers and young fruit. The summer spores (conidia) are large, barrel-shaped, and produced in chains (see figure under Rose Mildew). Leaves when attacked are stunted in size, more or less crumpled, and easily dry up and fall prematurely, so that the fruits and the young wood do not ripen. The fungus lives almost entirely on the surface, and can therefore be checked by sulphur and spraying. Mildew is sometimes a sign that the foliage is crowded through insufficient pruning, or that the trees are too close together, as is frequently the case with nursery stock. The winter fruits (ascus-fruits) harbour on dead leaves and bark. Cluster-cup Rust (*Rœstelia*, see under Juniper) is also easily identified by the yellow sticky spots on leaves, which later give off horn-like spore-cups (æcidiospores). Shot holes in the leaves are known to be caused by several fungi, but they may be due to insects, or to the action of too concentrated spraying solutions. Apple Scab (*Fusicladium* or *Venturia*) may be recognized as dark olive-green spots on the leaves, and as dry, cracked spots on the fruit. The spots and scabs bear little cushions of minute sporule-bearing branches, and the disease spreads rapidly. The winter fruits (ascus-fruits) hibernate on the bark or dead leaves and fruit, and in spring give off their spores. Leaf Scald (*Entomosporium maculatum*) produces on leaves reddish or brown spots studded with minute black points, the spore capsules. This disease is rather more frequent on the Pear (see Pear Leaf Scab). Discoloration of the fruit has been traced to many causes. One of the most frequent is bruising the skin when apples are shaken from the tree or carelessly handled in packing. The season, or some defect in the nutrition of the trees, may also result in spotted fruit, without the operation of fungi or insects. If spotted or bruised fruit is stored or packed, it is almost certain to be further damaged by common putrefactive moulds, hence the necessity for careful picking over and grading for the market. Discoloured or rotten fruit may, however, be caused by parasitic fungi, which begin operations on apples, pears, and other fruit while it is young. Brown Fruit Rot (*Monilia fructigena*) and Bitter or Ripe Rot (*Glœosporium fructigenum*) are the commonest. The symptoms in both cases are discoloured spots, which eventually become pitted with dark points, frequently arranged in concentric circles, and from these spores (conidia) are given off (fig. 2). If the disease has attacked young fruits, these may fail to mature, and remain hanging on the tree in a dry, mummified condition: these should be collected and destroyed before next season.

Prevention and Remedy.—The following general rules of treatment may be recommended:—

1. Since almost all the fungi referred to grow on or pass the winter in dead remains, the orchard should be cleared by removing and burning all dead branches, and burying or otherwise destroying dead leaves.

2. The use of tar for pruning cuts, especially the larger ones, has already been referred to. It will be absorbed better early in winter than in spring.

3. *Winter Treatment.* — Iron sulphate (see Fungicides), applied with a brush or a sprayer

once or twice before the buds swell, can be recommended for clearing off fungi harbouring in the bark.

4. *Summer Treatment.* — It has become the practice in many orchard districts to spray the trees regularly at intervals, and the practice has been amply justified by its success. In this way the growth of the foliage fungi will be checked much more effectively than by waiting till the disease is well on its way. Bordeaux mixture, both in the stronger and the more dilute form (see FUNGICIDES), has proved the best general spraying mixture. It may also be mixed with some insecticide and so serve a double purpose. For most of the fungi mentioned, the first spraying should be given as the buds approach the bursting stage. A second application is made just before the blossoms open, with dilute Bordeaux, to avoid damage to the leaves. A third spraying is necessary to protect the young fruit. Five and even more sprayings have been given during a single season at intervals of ten days or a fortnight; the number will depend, however, on the presence of parasitic fungi, and fewer applications will suffice in a dry season than when the fungicide is washed off by frequent rain. Bordeaux mixture is objectionable on the maturing fruit as it has the appearance of limewash, and should be replaced by the copper-ammonia solution, which contains no lime. As the fruit becomes ripe, it is well to discontinue the spraying. Care must be taken in applying any of these copper solutions, since they may discolour and injure the foliage. The strength of spraying mixture to be used must vary with the season and the variety of apple; as a rule it is best to experiment with the weaker, and to increase the strength in later applications (see SPRAYING, under FUNGICIDES). [W. G. S.]

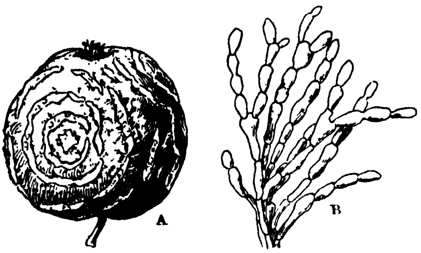


Fig. 2.—Brown Fruit Rot (*Monilia fructigena*)

A, Apple in mummy condition. B, Chains of Monilia spores (from Tubeuf)

Apple, Insect Enemies of.—The following is a list of insects injurious to the apple. *Aphis pomi* (the Apple Aphis), *Anthonomus pomorum* (the Apple-blossom Weevil), *Lyonetia clerkckella* (the Apple-leaf Miner), *Hoptocampa testudinea* (the Apple Sawfly), *Psylla mali* (the Apple Sucker), *Ægeria myopæformis* (Bark Borer), *Melolontha vulgaris* (the Cockchafer), *Cossus ligniperda* (the Goat Moth), *Clisiocampa neustria* (the Lackey Moth), *Anisopteryx æscularia* (the March Moth), *Hybernia defoliana* (Mottled Umber Moth), *Mytilaspis pomorum* (the Mussel Scale), *Aspidiotus ostreæformis* (Oyster-shell Bark Louse), *Blastodacna vinolentella* (the Pith Moth), *Cetonia aurata* (the Rose Beetle), *Xyleborus dispar* (Shot Borer Beetle), *Hyponomeuta malinella* (the Small Ermine Moth), *Orygia antiqua* (the Vapourer Moth), *Cheimatobia brumata* (the Winter Moth), *Zeuzera æsculi* (the Wood-leopard). For descriptions of these insects, their methods of attack and available remedies, see the specific articles APHIDES, ANTHONOMUS, LYONETIA, &c. [F. V. T.]

Apple Mill, a machine used in the cider-making industry. The apple mill is probably the oldest type of pulper extant. Long before the root pulper was thought of, the apple mill was used for reducing apples to a pulp before subjecting them to the cider press. In its early form it consisted simply of a wooden roller with nails studded all over it. The modern form has two pairs of rollers, one above the other. The first pair grip and crush the apples, the second reduce them to a pulp. [J. B.]

Apricot.—*Prunus Armeniaca* is a native of eastern Asia. It is said to have been cultivated by the Chinese thousands of years ago, and in India it has also long been grown for its fruits. It appears to have been first introduced into England from Italy in 1524, by Henry VIII.'s gardener, Wolff. It is quite distinct in foliage and bark from the other species of Prunus, its leaves resembling those of the Lombardy Poplar. The Apricot is, however, closely related to the plum, peach, and almond, as is proved by the fact that it is commonly grafted on a plum stock, and peaches and almonds are successfully grafted on apricot stocks. Some of the varieties reproduce themselves by seeds, Moor Park being one of these, which is propagated in some countries solely in this way, the seeds being planted in autumn 2 in. deep, and the seedlings transplanted after they are a year old. The general mode of propagation, however, is by budding on to the Mussel or common plum. Fruit nurserymen may be relied upon to supply young plants properly worked and trained of all the best sorts.

In the south of England the Apricot is grown in the open as a standard, and planted from 20 to 25 ft. apart as recommended for apples in orchards. Generally, however, it is cultivated against walls, a south-west or south-east aspect being preferred in the warmer parts, a position facing due south being more suitable in the north of the British Islands. A distance between the trees of 20 ft. should be allowed, and the training, usually what is termed the fan method, should be such as is practised for wall-fruit trees generally. Shoots that grow too vigorously should be stopped, preferably in July, by cutting off the upper portion, so as to divert the growth into less vigorous parts. Apricots prefer a light, loamy soil, well drained, trenched, and should the soil be on the heavy side, the addition of brick rubble, road scrapings, burnt soil, or wood ashes will help to keep it open and sweet. The flowers are produced on the one-year-old shoots and also on spurs two or three years old. It is therefore necessary in the autumn to lay in between the principal branches all the smaller shoots for which there is space, say at every 10 or 12 in., shortening them to a foot in length. By laying in, nailing or tying to the support is intended. After these lateral shoots have fruited they may be cut out to give place to young growths. In spring the borders should be well watered unless the soil is sufficiently wet. Apricots being deep rooters, it is essential that the soil below should be saturated. Established healthy trees in full bearing, after the fruit has stoned, will need assistance at the root, and should be watered with a liquid manure. The flowers of the Apricot develop early, and are liable to injury from frost; they should therefore be protected with nets or blinds, being covered every evening when there is a prospect of frost. When the trees set a very heavy crop of fruit, it would be advisable to remove a portion, not, however, until after the fruit have stoned. The Apricot, like the Plum, is liable to ruin its constitution by overproduction. The best varieties are the following:—

Frogmore Early.—A free-stone variety, yellow, mottled with red. Hardy, and a good cropper.

Moor Park. — The most widely cultivated, having large, tawny-yellow, speckled fruits, very juicy and of excellent flavour.

Royal. — Like Moor Park, but ripens about ten days earlier.

Turkey.—Fruit large, spherical, deep-yellow, spotted and blotched with orange; ripe on a south wall in mid-August.

Powell's Late resembles Moor Park, being quite as free and at least as hardy, but it is not ripe until mid-September.

Large Early.—A richly flavoured, large-fruited kind which is ready in mid-August. [W. W.]

Apricot.—Parasitic Fungi.—The fungi causing damage to the Apricot are either identical or nearly related to those on the Peach. See PEACH, PARASITIC FUNGI.

Gummosis or gum formation in the wood, with excretion of gum drops on the bark, may be followed by death of the branch. See CHERRY.

LEAF-DESTROYING FUNGI.—These include a mildew, several forms of discoloured spots, shotholes, and leaf-curl. The fungi concerned occur also on peach or on cherry, so that infection of the Apricot may come from these plants.

FRUIT ROT.—The same fungi which cause Peach fruit rot may also attack Apricot. Brown fruit rot (*Monilia fructigena*) seems to be most frequent, causing the fruit to dry up and remain hanging on the tree in a mummified condition; such fruits should be carefully collected and burned. See APPLE, PARASITIC FUNGI, where figures are given.

Treatment is the same as for peach-leaf fungi and fruit rot. When using fungicides for Apricot, dilute solutions only should be used, especially in the case of copper salts, which when used too strong have been found to cause shotholes and discoloration of the foliage; this is most likely to be the case with Apricots under [W. G. S.]

April, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE FARM.—*Corn Crops.*—Spring corn sowing is finished during this month if not already done. All autumn-sown crops and early spring beans are ready for hoeing, harrowing, and rolling. Grass 'seeds' and clover are sown on corn crops.

Fallow for next season's wheat is being ploughed first time after winter ploughing.

Forage Crops.—Lucerne may be drilled in on corn crop this month. Sainfoin is drilled across the barley as it comes up.

Tares are sown for a succession of sheep feed.

Cabbages that have been sown in seed beds early in March may be planted out at the end of April. Kail may be broadcasted for autumn sheep feed.

Dung is put on land for maize, and the first ploughing carried out.

Roots.—Kohlrabi is sown early in the month, either in rows or in seedbeds, to be transplanted later.

Mangolds are transplanted from the seedbeds, or they are now sown on the balk or flat.

Land is being got ready for turnips. Swedes are drilled from the middle of the month onwards.

The planting of the late main crop of potatoes is mostly finished in April, and early varieties that are now growing are cleaned and earthed up with a double mould-board plough.

Special Crops.—Early and main crops of peas, either for picking or seed, are ready for handhoeing. The late varieties are now sown.

The following crops are all sown during this month:—Carrots, flax, gorse, mustard, radish, teazel.

All crops not already sown in February or March should be put in during this month, as it is one of the spring seeding months.

Grass lands that are intended for hay should be shut up not later than the first day of April.

They should be harrowed and rolled to destroy antheaps and molehills, and to spread any dung, topdressing, or roughness on the same.

Manuring.—Liquid manure should be carted and spread on the grass lands. March and April are the months when the best effects are got from applying this.

All soluble artificial manures, such as nitrate of soda, sulphate of ammonia, or potash manures, may be applied broadcast over the grass lands, or to any corn crops that need it, if this has not already been done in the previous month.

Superphosphate is often sown on barley now, as it ensures better and earlier ripening.

STOCK.—*Horses* are now hard at work, and rations should be increased. This can be done by green forage, which should now be ready, such as winter rape, rye, and vetches.

Mares in foal are getting near foaling time, and should be given only moderate work.

Young colts are being broken in, and yearlings castrated before the flies come about.

On farms where early foals are bred, a great many mares are put to the stallion at this time.

Dairy.—This month marks the transition generally from winter to summer feeding.

Cheese making is at its busiest.

Cows are still brought in and fed and housed at night, but are left out towards the end of the month if the season be forward.

Autumn-sown rye and vetches, also 1000-headed kail, are ready for feeding now, and are handy to use before the grass becomes plentiful.

Cattle.—*Stores.*—If the season be forward, these can be turned out altogether from the yards where they were sheltered at night during winter.

Fattening beasts are fed on mangolds now, which are better than swedes at this time of the year. The last lot should be getting ready for market.

Calves are not fed for veal after this month till the autumn, but the ordinary rearing of the same for stock is now in full swing as the cows calve.

Sheep.—In this month the management of sheep is changed from winter to spring feeding. It is only in an early season that there is much young grass available. Roots are likely to become scarce at this period, and hay and straw will have to be supplemented with cake or meal to tide over the time till grass becomes plentiful.

Catch crops sown after harvest, such as rye, winter oats, vetches, winter barley, should be ready for folding.

Lambs can be fed in troughs on mangolds or swedes chopped up. If it is a warm season, the ticks are likely to become troublesome, and so sheep must be well looked after, or the long-woolled ones will roll on their backs and suffocate. Early dipping may now be carried out with 'summer dip'. [P. M'C.]

2. Northern Britain

This is the month in which the bulk of the oats and barley are usually sown. If the season has been a dry and early one, a portion of the crop may have been sown during the latter half of last month, but in the most of years, and on heavy land particularly, it is only occasionally that the land is in condition for sowing before April. Grain of all kinds benefits by early sowing, but a good seedbed is of more importance than the date of seeding. As soon, therefore, as the land becomes sufficiently dry to easily carry the horses, and permit of the harrows working well, seeding should begin, and be carried energetically on, as long as the weather remains favourable. If it is desired to sow any of the land in oats with grass and clover seeds, these should not be sown till a week or ten days after the oats. It is not often that the weather is so unpropitious at this season that this cannot be done; but should it happen that the work is unfinished before the braird appears, the sowing, or at least the harrowing, should cease for a time. When the young oat plant is coming through the ground it is very easily hurt, either by the feet of the horses or the harrows, although it can stand considerable tramping and harrowing without injury as soon as the second leaf has been formed. This is the stage at which to sow any grass seed which has been left over, and on land infested with charlock or runch, a stroke of light seed harrows at this stage will do little harm to the oats, and uproot a considerable proportion of the recently germinated charlock seeds.

The planting of potatoes should be vigorously carried on from the beginning of the month, beginning first with the second earlies, and finishing with the lates. Any land intended for either of these, which has not been sufficiently cultivated, or is not quite free of root weeds, should have attention whenever the land is in suitable condition. All potatoes intended for seed, which are not in boxes, or which have not been recently turned over, should be re-dressed, so as to check growth, and save time when the busy period arrives. Drumhead cabbages should be planted as early in the month as circumstances will permit, and in doing so all small or damaged plants should be discarded. Mangolds should be sown during the second week. Weeding is saved and a better plant secured if the seed is soaked in water, kept in a warm place, and turned daily for a week before being sown. Where early turnips of the Golden Stone type are grown for table use, the first sowing should be made between 20th and 25th of the month. If sown any earlier, there is great risk in many seasons of many of them running to seed. A second sowing may be made at the end of the month. If rhubarb is grown and is forced, the last of it should be cleared off as quickly as possible, as the new crop outside is usually ready about the middle of the month. Any nitrate of soda which it is intended to apply to hay should be sown soon after the crop begins to grow. If the land is flat, and not in ridges, or in any way marked off for sowing, if rolled first, a couple of breadths of the roller may be sown at a time.

Cows should now be fed a large proportion of their fodder in the shape of hay, as straw becomes very unpalatable after this. Mangolds should be fed instead of turnips if they are available, and during good weather the byre doors should be opened and the building freely ventilated. Where calves are reared, their quarters should be kept scrupulously clean, so as to prevent white scour and other ailments. Should it appear, remove all healthy ones to another building. [J. S.]

April, Calendar of Garden Operations for.—

1. Southern Britain

The following directions for the work of the month apply only to the London district and those parts of the country in which the temperature, &c., are approximately the same as in the neighbourhood of London. Each month will be dealt with in alphabetical order. April should be a busy month. In the kitchen-garden operations by this time will have made considerable progress; all digging, manuring, transplanting, should ere this be completed, and everything be in readiness for seed sowing. Seeds of the following should be got in whenever the weather and soil conditions are favourable:—Asparagus, Beans, Beet, Borage, Borecole, Broccoli, Cardoons, Carrots (second sowing), Cauliflowers (for late summer crop), Celery (under glass), Chicory, Endive, Fennel, Kidney Beans (warm situation), Leeks (second sowing), Lettuce (second sowing), Onions (beginning of month), Parsley, Parsnips, Peas (marrow-fat sorts, sow thinly in rows not less than 6 feet apart), Potatoes (main crop), Radishes (these should be sown once a fortnight from first week in March to end of June), Savoys, Sea Kale (or propagate by root cuttings), Spinach, Turnips (once a fortnight). Fresh plantation if required should be made of the following:—Artichokes, Rhubarb (divide the roots, leaving two or three crowns on each plant), Sage (cuttings in a hand light).

In the fruit department all planting and pruning operations must come to an end. Apples and pears may be grafted; wall-fruit trees in flower must be protected at night whenever there is danger from frost or cold wind. Should the weather be dry, it may be necessary to afford liberal supplies of water at the root to border trees, and especially those that have recently been transplanted. The strawberry beds should be mulched with a straw manure, which will serve the double purpose of feeding the plants, and afterwards protecting the fruit from being soiled. These plants also pay for a heavy watering. If procurable, manure water may be given once a week, as strawberries during this month make their principal effort, and if liberally treated they set well for fruit, and the fruit is larger. In the flower garden and shrubbery, preparations should be made for the summer display. April is the best month for transplanting evergreen shrubs, such as Rhododendrons, Hollies, Ericas, Aucubas, Laurustinus, Bamboos, &c., preferably during showery weather; failing this, they must be liberally watered immediately after planting. Roses should be pruned before the middle of the month, and it is not too late to replace failures with well-rooted plants obtained from a northern nursery. After pruning, rose beds should be well mulched with good, short, well-rotted manure. All beds and borders in which summer bedding plants are to be grown may now be dug over, manuring them if necessary. It is not too late to patch up lawns, or to take up the turf for the purpose of levelling; where the grass is weak, a dressing with well-rotted short manure or a mixture of guano and fine soil should be applied during the early part of this month. Where plants are grown in frames or greenhouses for summer bedding, these must now receive attention. Cuttings of Pelargoniums, Dahlias, Heliotropes, and Fuchsias should be put in, preferably where there is artificial heat, a manure hotbed being best. The seeds of tender annuals, such as Asters, Stocks, Lobelias, and Cinerarias, should be sown. Herbaceous perennials may be put out any time during this month, and the bulbs of Gladiolus, Galtonia, and Lilies planted where they are to flower. In the early part of this month seeds of such annuals as Mignonette, Musk, Phlox Drummondii, Godetia, and Sweet Peas may be sown where they are to flower. [W. W.]

2. Northern Britain

When cropping operations have been delayed through stress of weather or other adverse circumstances, the first favourable opportunity should be taken to sow early peas, broad beans, onions, leeks, parsnips, parsley, potatoes, and all the cabbage tribe for autumn use. Dwarf varieties of peas are best for early work. In regard to peas for moderate-sized gardens, select medium-growing sorts, of which nowadays there are many fine varieties. The same may be said of most garden vegetables, especially so of potatoes. There is not much wisdom, and no gain, in crowding a garden with coarse or large-growing types of vegetables; these, if desired at all, should be cultivated in a field. From the middle of the month sow successive lots of peas, lettuces, early white turnips, early horn carrots, and spinach. Towards the end of the month the main crop of carrots should be sown, also beetroot. Too frequently these are sown earlier, and thus are liable to get touched by frosts in May, with the result that the bulk of the crop 'bolts' to seed. Celery, vegetable marrows, and any semi-tender herbs should be sown in frames. Where tomatoes are grown, see that the plants are allowed plenty of light and space, so as to ensure stocky plants; rub out the side shoots and grow the plants on a single stem. The temperature of the tomato house should range between 50° and 55° at night, according to the weather. Keep the plants in a good growing temperature, avoiding the two extremes, also cold draughts, of which these plants are very impatient in the early stages of growth. In the floral department sweet peas must be sown early; where the soil is naturally cold and stiff, sow the seeds thinly in pots or boxes, and when the plants are about 4 in. high they can be planted out where they are to flower. A selection of the most useful hardy annuals may be sown towards the end of the month. Stocks, Asters, Marigolds, Annual Chrysanthemums, Scabious, and Antirrhinums should be sown under glass. If sown thinly in lines in a glass frame, they can be planted directly into their blooming quarters in due time without the usual intermediate operation of being 'pricked out'.

Where mice and birds are troublesome, such seeds as peas, cabbages, &c., should be treated with red lead, which is one of the best deterrents yet discovered. Place the seeds in a convenient dish, slightly *damp* them, taking care not to wet them too much, then sprinkle on the dry red lead, and give the seeds a stir, when sufficient will adhere to serve the purpose. A little practice will soon teach the operator how to act.

Herbaceous plants may be divided and planted where necessary, but do not allow the plants to be too far advanced in growth ere performing those operations. Too frequently there are more shoots left on most of the hardy border plants. Where time admits, thin out at least half of the shoots from Phloxes, Asters, Helianthuses, and similar growing plants. Plant out Liliums, Gladioli, and similar subjects where they are to bloom, giving a light shelter for a time if the weather becomes stormy.

The planting of deciduous trees and shrubs ought to be finished early in the month, though evergreens such as Rhododendrons, Aucubas, Hollies, Boxwood, &c. can be dealt with for some time yet. In light soils it may be necessary to water some of the plants, but do not water if it can be avoided; rather mulch the surface with rough leaf mould or short litter. Boxwood edgings should be repaired or relaid where necessary. Patchy lawns should likewise receive attention by topdressing and resowing with the proper seeds. Do not use the sweepings of the hayloft for lawns; such may do for woodlands, but never for lawns or pastures. [J. WH.]

April Wheat, a variety of wheat whose only special merit is that it can be sown as late as April and still complete its ripening. See WHEAT.

Aptera, an order of primitive insects, popularly called 'Springtails', composed of two groups, Collembola and Thysanura. They never have wings or rudiments of such, but three pairs of legs, and long or moderately long antennæ. There is no true metamorphosis; the larval stage is practically retained throughout life. The Collembola have the power of leaping, which is accomplished by means of a long, forked, ventral process towards the anus. The abdomen has six or less segments. The Thysanura do not skip, and have ten abdominal segments. Some Collembola are injurious, feeding on plants, &c. (Smynthurus), and a few Thysanura, as the Silver Fish (*Lepisma saccharina*), destroy books in houses. [F. V. T.]

Apterococcus fraxini (the Felted Ash Coccus).—This cottony ash-scale insect resembles to some extent the Felted Beech Coccus, but is not so serious. It lives chiefly on the trunk, but may invade the boughs of ash trees. The adult female is bright-red and almost globular; she retains her legs but seldom moves. The male has no wings, and scarcely any distinction between head, thorax, and abdomen. The young and adult females form small whitish, felted masses over themselves similar to the Beech Coccus. Trees of all ages are attacked, but smooth-barked ash are preferred. It is abundant in Gloucestershire, Cheshire, and Hertfordshire, and to some extent in Kent. *Treatment* is the same as for *Cryptococcus fagi*. [F. V. T.]

Aquatic Plants.—The water garden has become a popular feature in British gardening. Where a pond or stream is available it is easy to make provision for a collection of aquatic plants. The most suitable position is by the side of a wide stream, where the water is always changing, but there are plenty of ornamental plants that will thrive where the water is still. The best effects are obtained where the disposition of the plants is as natural and simple as possible. If stones are used they should not be formal, and rustic bridges and such artifices are rarely pleasing. In addition to the aquatic plants, such trees as willows, dogwood, alders, and deciduous cypress may be used, and here and there a group of bamboo, pampas, spiræa, polygonum, bog myrtle, and the larger ferns may be used for the margins of water. The best floating plants are the hardy water lilies (Nymphæas), of which there are a great many varieties, including white, pink, crimson, and yellow flowers. The Nuphar, or common Yellow Brandy Bottle, is worth a place in large expanses of water. Aponogeton, the Cape Pond Weed, is another suitable plant. *Villarsia nymphæoides* is also worthy of a place. More erect growing plants are the Japanese *Iris lævigata*, the Sweet Flag (Acorus), the Water Buttercup (Caltha), Gunnera, Porcupine Rush (*Juncus zebrinus*), Arum Lilies (Richardia), *Saxifraga peltata*, Bog Arum (Calla), Bog Bean (Menyanthes), *Thalia dealbata*, the Reed Maces (Typha), or Bulrushes as they are called, Canadian Rice (*Zizania aquatica*), and Rogersia. Other plants which are happiest when grown with their toes in water are *Cypripedium spectabile*, the Globe Flowers (Trollius), *Primula japonica*, the Royal Fern (Osmunda), and such lilies as *L. canadense* and *L. pardalinum*. [W. W.]

Aqueous Rocks, rocks that have been formed in beds or strata under water. See SEDIMENTARY ROCKS.

Aquilegia.—The Columbines belong to the Buttercup order, all the species being hardy. They are among the most useful of hardy herbaceous border plants, and recently they have been vastly improved in regard to stature and colour. It is now possible to obtain from a packet of seeds sown on a bed prepared as for onions, a batch of plants which, when transplanted into the open border, preferably in light, moist soil, will in their second year flower profusely, and comprise various colours from white to blue, crimson, and yellow. The species from which the best garden varieties have been obtained are all natives of North America. *A. vulgaris* is a native of the British Islands, and of it there are many forms in cultivation as garden plants. [W. W.]

Arabian Horse, The.—Although the position formerly claimed for Arabia as the sole original home of the horse in his wild state has long been abandoned, and although even the extreme antiquity of the horse there as a possession of the Bedouin Arabs has been denied by such high authorities as Hamilton and Pietrement, the balance of scientific opinion in our day seems to be that the Kehailan or Arabian thoroughbred represents, in reality as by tradition, a primitive wild horse stock indigenous to the Arabian peninsula. Like the Barb, his fellow progenitor of the English racehorse, the Kehailan would seem to have acquired his special characteristics of speed, sobriety, and endurance, with his fineness of coat and limb, from the long isolation of his kind among desert surroundings—surroundings which have imparted the like qualities of beauty and what we call high breeding to the hare, the fox, and the gazelle, indeed to all desert mammals. These last qualities can hardly have been acquired under domestication, and must therefore represent peculiarities inherited from the wild state. But it is not at all necessary to suppose a common ancestry between the two desert horses. The Arabian is probably an offshoot of the Asiatic, the Barb of the European wild stock. They are distinguished from each other by difference of conformation sufficiently marked. Whereas the Barb is what the Arabs call 'ram-headed', that is to say, with a convex profile line, the Arabian has the upturned nostril and slightly concave profile of the gazelle. He has the high wither which makes him pre-eminently a saddle horse; and above all, his tail, instead of being set low and carried meanly between his hocks (the Barb characteristic), springs from the highest level of the quarters and is carried high. These are points of bone structure not to be overlooked, and are important in the Arabian as indications of pure breeding.

The horse of the Bedouin Arabs, though held in immemorial honour among themselves, first came into prominence with the world at large through the great Mohammedan conquests of the 7th and 8th centuries of our era. It was as a warhorse for light cavalry that he was first recognized, one unmatched for endurance in campaigning, especially in arid lands on insufficient food with little water. In this character he overran Western Asia, India, and North Africa, and carried the flag of the Caliphate into Spain and Southern France, the special value of the pure Arabian blood being recognized by a rule of war which assigned one share of the booty acquired to a foot soldier, two shares to a mounted man, and three shares to the rider of a horse of pure Arabian breeding.

High prices seem at all times to have been given for the pure Kehailan blood. Sums are recorded which it is difficult to calculate exactly in our money as having been paid to Bedouins for individual horses by kings and princes in the early Caliphal days, which must have been far in excess of those paid for other horses. Later we have testimony to their money value in a long series of notices left us by European travellers and Oriental annalists, among whom may be mentioned Marco Polo (1290), Makrisi (1440), Niebuhr (1762), and among Englishmen, Sir Henry Blunt (1635) and Hamilton (1723). The home trade with India was already well established in Marco Polo's time, and he gives 100 marks as the current price paid at Aden for horses exported thence. Blunt gives as the price of the true desert blood horse at Cairo 1000 pieces of eight, and Niebuhr says: 'The English in India purchase these Kochlani (Kehailan) at 800 or 1000 crowns each'. The most important writer of those mentioned is, however, Makrisi, whose account of the horse-racing carried on in the time of the Mameluke sultans of Egypt is most instructive.

It was in the 14th century, under Sultan el Nassr, that horse-racing first took a definite shape at Cairo under rules as to training, weight-carrying, distances, and even, it would seem, betting, not very different from those introduced at Newmarket 300 years later by our Charles II. El Nassr was a contemporary of our Edward III, and during his long reign the sport reached its highest point of development under royal patronage. Till then the Barb had been in favour with the Mamelukes for their military evolutions, but under El Nassr horse-racing proper became a chief feature of all displays, and the superiority of the Kehailan was at once apparent. Agents from the sultan visited every province of Arabia, and immense sums were given, as much, Makrisi affirms, as 60,000 and 75,000 drachmas for stallions and 80,000 and 90,000, and in one instance 100,000, drachmas (£3000) for brood mares of the purest strains of blood. A great breeding stud was formed at Seriakus, the finest probably that the Eastern world has seen, and rivalled only in Egypt by that got together at a cost of half a million [illegible] Viceroy Abbas II. In both studs everything was managed by Bedouins in accordance with Bedouin ideas of breeding, nor was any expense spared. Egypt, however, is not a land suited by nature to the horse, as it is almost entirely without natural pasture, and with the death of El Nassr, as later with the death of Abbas, his racing stud degenerated and was finally dispersed.

The systematic introduction of the pure Kehailan into Europe dates from the 18th century only. During the previous century, racing had come much into fashion in England, and much Eastern blood had been imported, principally Spanish and Barb, but now for the first time stallions of authentic blood were procured from Aleppo and other towns on the desert edge, with an immediate effect on the quality and speed of the English racehorse. The most famous of these sires, and the best authenticated, was the Darley Arabian of the Managhi strain, one of the best breeds of the Anazeh Arabs. This horse was procured for Mr. Darley, a Yorkshire squire, through his brother, who was at the time British Consul at Aleppo. Another, almost equally famous, but whose pedigree remains obscure, though he is said to have been a Zilfan, was the Godolphin, and to these two Arab sires, in varying proportions of blood, every horse in the English General Stud Book traces his pedigree. It is impossible to enter into any nice calculation here, but it may be affirmed generally that at least three-fourths of the blood of the modern English thoroughbred is derived from Arabia, and that to the Kehailan he owes the initial quality of speed, which two centuries of selection has developed into the perfected racehorse we now possess.

Such, briefly stated, has been the Arabian in the past. His modern uses are of a different but hardly less important kind. As a sire of racehorses his day is over in Europe, for the English thoroughbred, bred for no other purpose, has so far outstripped him in speed that his own unimproved pace, though greater still than that of any other natural breed, can no longer be of service on the racecourse. Even in India, where he long held his own, he is seen less and less often in competition with the thoroughbred 'Waler' of Australia, which has command of the modern Indian market. As a sire, however, of half-bred stock all the world over, and especially in those countries where the conditions of life are hard, the Kehailan's value is becoming yearly more recognized. It has been found in Australia, South Africa, and all the subtropical regions subject to great variations of temperature, droughts, and scarcity of pasture, that horse stock got by an Arabian stallion will by its superior hardihood of constitution outlive that got by an English thoroughbred, while retaining all the essential features of high breeding, sufficient speed, staying power, and courage. The Arabian has, too, this advantage over the thoroughbred—an admirable temper, which transmits itself to his progeny. This, with great soundness of wind and limb, and comparative immunity from disease, makes him of the utmost value to colonial breeders, and such is now his principal function in the world beyond seas. In Europe all the great military Powers understand his merits as a stallion for military purposes, and he is found very generally in use in the government studs. In England, almost alone of European countries, his services are little asked for, the reason doubtless being that we breed no horses specially for cavalry purposes. What breeders aim at in England, apart from the heavy cart breeds and polo ponies, is to produce a weight-carrying hunter or high-actioned hackney for show as much as for use. These may bring a high price, while horses less showy but fit for real hard work are little needed, and it does not pay to breed them. Nevertheless it may be confidently affirmed that out of big-boned mares better hunters will be bred with a first-class Arab than with any but a very exceptional thoroughbred stallion. Such stock will be found to have far more even qualities of courage, temper, and endurance, besides being sounder than the other, with hardly less size. It is, however, essential that the Arab stallion employed should be thoroughly well selected, not only with regard to pedigree but also to the special points of breeding peculiar to his class. It is not one colt in twenty bred in the desert, even of the purest strains of blood, that is considered worthy of being used there as a sire, and the same caution should be practised in selecting a stallion for use in England. The points to be regarded are principally these.

Apart from the general rules of a soundly developed frame and freedom from constitutional defects, what one choosing an Arab sire should look to is the shape and setting on of the head. This, with a proper carriage of the tail, is the best indication of pure breeding, and its absence implies almost always a faulty pedigree. The head should be beautiful, not necessarily small, but fine and clean-cut, with good depth of jowl, breadth between the eyes, and breadth between the cheekbones. These should be clean of flesh, and the eyes large and prominent. It is no sign of temper in the Arab horse that the eyes should show white round the cornea like human eyes, but a peculiarity of the breed appreciated by the Bedouins. The line of forehead should be rather concave than convex, that is to say there should be a slight prominence between the eyes with a corresponding slight depression beneath them, giving a delicate upward turn to the muzzle, which cannot well be too finely tapered. The saying that an Arab horse should be able to drink out of a coffee cup is hardly an exaggeration. The skin of the muzzle and round the eyes should be dark and bare of hair; the ears small in the stallion and finely cut; the nostrils set higher than with other horses. The proper attachment of the head to the neck is of great importance. However strong the neck, the attachment should be delicately curved. The mane should be ligh and fine, also a point of breeding. So, too, should be the tail; this should be set on high, springing as nearly as possible from the highest level of the croup and rising higher than any part of it. Such a carriage of the tail is a feature special to the pure Kehailan, and so of great importance. These points of breeding noted, a good judge of thoroughbred stock will not often go wrong in his choice of an Arab sire. The Arab wither is high, with more of a saddle back than the English thoroughbred commonly shows, the effect of a higher croup and better ribbing up. Also the cannon bone is shorter and the hocks and knees are more strongly developed. But on all other points of shape, what would recommend a thoroughbred stallion to a breeder should also recommend an Arab stallion. His action should be from the shoulder and not from the knee, and he should bend his hocks like a deer.

The best height for an Arab stallion is from 14·2 to 15 hands, rather less than more, 14·2½ being perhaps perfection. It is seldom that a horse of this height shows more than 7½ in. measurement below the knee. More than 7¾ in. generally denotes a coarser strain of blood. The hoofs should be perfectly round but deep and strong, not donkey shaped or narrow. The question of colour has been much debated. There can be little doubt that bay or chestnut was the original wild colour, as there is a clear tendency to reversion to them. The Bedouins themselves prefer bay, which they think the hardest, but chestnut with three white feet (the off fore dark) is perhaps still more preferred, and it is usually in this combination that the handsomest types of Kehailan are seen. White and flea-bitten greys are favourites with the townspeople, who have a tradition that grey was the Prophet's special choice, and for this reason care is taken to breed for it; but it is certainly not the original Kehailan colour, as a grey colt is never foaled to two bay or chestnut parents, whereas two grey parents will often produce a bay or a chestnut. Brown is an uncommon colour, black an extremely rare one. It is generally admitted by breeders that the type is more perfectly produced with a chestnut sire than with any other. It is also believed that chestnut is the original, as it is the most constant Kehailan colour. Alone of all the colours two chestnuts will always produce a chestnut.

Finally, a word must be said about the sources from which pure Kehailan blood may at the present day be procured. It is a melancholy fact that in Arabia itself it is becoming yearly more difficult to purchase first-class specimens of the true Arabian breed. For various reasons, which it would be too long here to relate, but principally from the introduction of firearms among the tribes, and the greater facilities given to exportation by steam communication during the last forty years, the breed has declined, and it is hardly any longer possible to obtain stallions of the class needed in the traditional markets. At Aleppo, Damascus, and Bagdad, where thirty years ago the supply was still abundant, it is rare now to find a stallion worth importing to Europe. Even at Bombay this is the case, and to the extent that latterly the Indian remount department, having at last resolved to establish a pure Arabian stud for military use in Northern India, has found itself obliged, in default of first-class stallions procurable at Bombay, to make its chief purchases in Europe. The Continental government studs are in the same plight, and the yearly commissions sent by them at great expense to the Syrian and Mesopotamian deserts have latterly returned almost empty-handed. On the other hand, studs have been started outside the Arabian peninsula in which pure Kehailan stock is being successfully raised, and with good promise of rescuing this valuable blood from the extinction threatening it in its primitive home. The most important of these are the two great studs in Russian Poland belonging to Count Potocki and Countess Branicka, both dating from nearly a hundred years ago, with a new one on lines of still more authentic breeding, the property of Prince Scherbatoff. Sultan Abdul Hamid has an extensive establishment at Constantinople, which is not, however, accessible to the unofficial purchaser. In Austria and Germany their respective governments are breeders of the pure Kehailan, and studs have been started in Australia and North America. Above all, in England the Crabbet Arabian stud, founded in 1877 by Mr. Wilfrid Blunt in Sussex, has proved successful in producing the Kehailan type in its full purity. The prices there current for breeding stallions have of late years been from 80 to 200 guineas, nearly all given for foreign and colonial exportation.

[W. S. B.]

Arable Farming.—The designation of *arable* is applied to a farm the whole of which is kept under tillage, and *arable farming* is thus distinguished from *pastoral farming* (see art. PASTORAL FARMING), in which the land lies wholly in pasture, and from *mixed farming*, in which part of the land is under tillage and part is unreclaimed mountain land or permanent pasture (See also succeeding article on ARABLE LAND.)

The total area of land under arable cultivation in Great Britain and Ireland in the year 1907 was 19,490,304 acres. This was inclusive of land under temporary pasture or rotation grasses, and it is not to be understood that the whole acreage described under the designation of arable land is every year turned over by the plough. Arable farms are cultivated on various rotations, in none of which is the whole farm annually under tillage. In the four-course rotation three-fourths of the land are ploughed every year, in the five-course three-fifths, and in the six-course one-half of the land is cultivated, while the remaining half remains under rotation pasture. In some rotations on poor land farms the temporary pasture may continue as long as five years, and in exceptional cases for an even longer period: while, on the other hand, on rich and fertile soils, such as exist in parts of Lincolnshire and the Lothians, the land may be under grass or hay not more than once in six or eight years. On the whole, it is probably correct to estimate that of the total area of arable land in Britain about three-fifths are annually turned over by the plough and otherwise cultivated.

As distinguished from pastoral farming, the system of arable farming demands on the part of the farmer a much wider range of knowledge, the exercise of greater energy, and a more constant attention and assiduity. He requires to understand the whole art of tilling land, as well as the proper uses and relative merits of the implements and machines necessary for that purpose, and he must know also the special preparation required for the particular crops he intends to grow. He should understand how to choose the crops to be grown, how to select and prepare the seed, how to apply manures, how to prevent or treat the diseases to which the crops are subject, how to protect them from attacks of insect enemies, and how to secure them, when grown, from the dangers to which they are exposed in an inclement and changeable climate. He must know how to obtain the best returns for the crops after they have been safely stored, must find the most suitable markets for them, and must sell to the best advantage. It will be necessary also, except on those farms situated in the immediate neighbourhood of large towns or cities, that he should arrange for the consumption of a large portion of his crops by cattle or sheep, and he must therefore acquire a knowledge of the various live-stock breeds, of their relative values and suitableness for his purposes, of their feeding and management in the best and most economical manner, of their treatment in health and disease, and of their purchase and sale. In short, the successful management of an arable farm requires the most complete knowledge of agricultural practice and science in all its branches, combined with sound judgment, energy, and good business capacity.

Arable farming also requires the greatest amount of capital that can be employed in the cultivation of the land, and the total returns in yield of crops are greater than can be got either in mixed or pastoral farming, in due proportion to the closeness of the rotation and the intensity of the system of cultivation adopted. It combines at once the greatest employment of labour, the largest investment of capital, the highest productiveness, and the greatest knowledge and skill on the part of the farmer, and it may therefore justly be regarded as constituting the highest development among farming systems.

The size of arable farms is, as a rule, much less than that of pastoral farms, and it is limited by considerations that affect alike the efficiency and the economy of their management. The operations of an arable farm necessarily centre round the farm steading and the barnyard, in which the crops are secured and the live stock housed in winter, and to some extent also in summer. The horses and men employed in the cultivation of the fields must travel from the steading in the morning, must return for their midday meal, and must again go out and return from the labours of the afternoon. The farmyard manure made in the byres or cattle boxes has to be carted to the fields, and if any of them be so remote that it is considered better to apply the whole of the manure to parts of the farm nearer the steading, the more distant fields will be deprived of the advantages attending its application. The crops also have to be carted to the steading, where the fodder is stored and consumed, and where the roots used in the feeding of cattle are also conveyed for consumption. Every additional yard of distance from the farm steading therefore adds to the expenses of cultivation and to the costs of growing the crops, while it adds also to the risks incurred by the crops in a bad harvest season, because they cannot usually be so rapidly conveyed to the barnyard. The efficiency of the superintendence is also affected by the size of the farm. On a large holding, such a close and constant supervision over the execution of work cannot be exercised as on a smaller farm, and some slackness and dilatoriness is unavoidable. It cannot be for nothing that the attention and energies of a farmer are concentrated on a farm of 300 ac. instead of being diffused over one of 1000 ac., and except in the case of farmers of unusual capacity the former will generally be the better managed. Much depends, however, on the rotation followed, for on a 200-ac. farm cultivated on the four-course shift there will be as much land annually ploughed as on a 300-ac. farm cultivated on the six-course shift. The greater area of arable land in England and Scotland is occupied by farms ranging in extent from 200 to 500 ac., though there are some larger and many smaller. In Ireland the land is generally occupied by much smaller holdings. See also arts. on Pastoral Farming; Farming, Systems of; Rotation; Statistics; Arable Land, &c.

[R. P. W.]

Arable Land.—The word *arable* means 'fit for ploughing or tillage', and the term 'arable land' in its correct and full sense, therefore, includes all land that is capable of being cultivated according to the ordinary methods of husbandry. This embraces all classes of land except mountains, forests, and woodlands, morasses and waste sands, which either from their position or their physical and chemical characters are unfit for cultivation in the usual manner, though by special means and with extra labour and expense they could no doubt be made capable of growing certain farm crops. In the Government Returns the term 'arable land' is applied in a restricted sense to land that is actually under regular rotation cultivation, and that is producing alternately crops and grass, while land permanently laid down to grass is excluded, though it may be quite suitable for cultivation. This application of the term *arable* is incorrect, but was doubtless adopted in order that the extent of land actually under tillage at any time might be clearly distinguished from that under permanent pasture.

In its proper sense of land capable of tillage the area of arable land in Britain can have undergone no material change in recent times, but in its restricted sense, as employed in the Government Returns, as land under rotation cultivation, there has been a great reduction in the past thirty years in the amount in Britain and Ireland.

This is shown in the following table:—

	Great Britain.		Ireland.	
	1875.	1907.	1875.	1907.
Area of Land under Crops and Temporary Pasture ...	18,103,729	14,965,563	5,342,942	4,524,741
Permanent Pasture, exclusive of Mountain Land ...	13,313,621	17,277,884	10,431,776	10,104,852

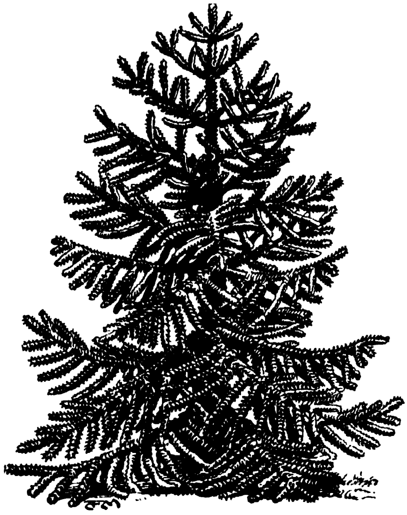
The land capable of cultivation in England and Wales amounts to about 74 per cent of its whole acreage, in Scotland to about 25 per cent, and in Ireland to about 73 per cent. Even with the inclusion of the highly mountainous country of Wales, which contains relatively less land fit for tillage than either Ireland or Scotland, the proportionate acreage of arable land remains much greater in England than in any other part of the United Kingdom. It is also of much more diverse character and value, containing as it does tracts of poor sands and chalks, alternating with tough and tenacious clays, rich marls and loams, and alluvial soils of great fertility. The arable soils of Scotland are less varied in character, but in some counties have a high value and productiveness, while in Ireland, along with limited tracts of very fertile land there exists also a greater acreage of poor moss land than in all other parts of the United Kingdom.

The diminution in the area of the arable land under cultivation, and the increase of that which has been put under permanent pasture, has been due chiefly to the effects of large foreign imports of grain and other agricultural products. The fall in values which naturally followed on the increased supply of these products, coinciding as it has done with a rise in wages and in other costs of production, has rendered the cultivation of great areas of the poorer arable lands of Britain unprofitable, and has caused them to be sown down to permanent pasture.

See also arts. on Arable Farming, Rent, Statistics. [R. P. W.]

Aragonite. — A mineral with the same composition as calcite (calcium carbonate), but crystallizing in the rhombic system, and with a specific gravity of 2·94. The shells of most living molluscs, and the hard parts of most corals, are formed of aragonite. When calcium carbonate, moreover, is precipitated from the calcium salts dissolved in sea water, as in the formation of oolitic grains (see LIMESTONE, OOLITIC), the resulting mineral is almost always aragonite. Calcite, however, is deposited when the precipitation takes place from calcium bicarbonate in temperate or colder waters. Aragonite changes, in a comparatively short geological time, into calcite; hence fossil limestones, even when originating as shell banks or coral reefs, are found to consist of calcite. [G. A. J. C.]

Araucaria, a genus of lofty evergreen Conifers indigenous to Australasia and South America, and closely allied to some of the ancient fossil remains found in carboniferous limestone. The several species include the *A. imbricata* or Chile pine; the *A. excelsa* or Norfolk Island pine, the biggest of the species, with a height of over 200 ft. and a girth up to over 30 ft.; the *A. Cunninghamii* or Moreton Bay pine of New South Wales; the *A. Bidwillii* of the same district, yielding large edible seeds; and the *A. brasiliana* or Brazil pine, also furnishing edible seeds, as well as a waxy resin used along with wax for candle-making in Brazil. Of these, the only species that can be easily grown in the open here or throughout Central Europe is the Chile pine, better known as the 'monkey-puzzle' from its hard, sharp-pointed leaves. On the western slopes of the Andes it forms large lofty forests at 1600 to 2000 ft. elevation, with stems up to about 150 ft. high (female stems up to over 200 ft.; the flowers are diœcious), and yielding heavy, hard, yellowish-white timber of good quality. Its seeds are about an inch long, have a sort of chestnut or almond flavour, and form part of the food of the Araucanian tribe (hence its generic name), and mature female trees bear from 20 to 30 cones, each with 200 to 300 seeds. It was introduced into Britain in 1796, and is conspicuous in the gardens of town and suburban villas. Perhaps the most extensive plantation of Araucaria is that at Powerscourt, Co. Wicklow, where a large number were set about forty years ago in wide squares. The effect is peculiar rather than beautiful, as the habit of the tree is stiff, formal, and candelabrum-like. It grows best on a light, easily penetrable, and well-drained soil, and in a free, airy situation. Given these, it is fairly hardy throughout most parts of Britain, and only requires protection against frost while still young. [J. N.]



Araucaria imbricata

Arbiter. — An arbiter or arbitrator is a person either voluntarily chosen by the parties to decide disputes or differences between them, or appointed by some official body (*e.g.* a court of justice, the Board of Agriculture, &c.) to act in such capacity. In the case of an arbiter appointed by the parties themselves, anyone may act whether under disability or not; thus a minor or a married woman may competently act. An arbiter must be absolutely unbiased, and any secret interest in the subject of the reference, or any bias either for or against any of the parties, will disqualify him. But his interest must be unknown to the parties, for if, knowing of his interest, they appoint him, they will be held to have waived all objections, and neither party can thereafter plead this as a disqualification. Moreover, the interest must be of such a nature as will almost inevitably affect the justice of his award. It is frequently agreed in contracts for the execution of railway or other work that disputes arising in connection with the contract should be referred to the engineer or architect of the company. In such a case the engineer is employed and paid by one of the parties to the reference; and though the contractor may thus be compelled to submit to apparent injustice, the Court will not interfere, on the ground that by agreeing to a reference to a party whom he knew to be a servant of the other contracting party he had barred himself from objection. Even where two arbiters are appointed, one by each party, it is of the utmost importance that the arbiters hold themselves quite impartial, and that they do not act as if they were appointed to safeguard the interests of their respective nominators. If, therefore, a party has given assistance or advice in making up a claim, or otherwise, he ought not to accept nomination as arbiter in any reference which may be resorted to to settle the matter in dispute. The arbiter has full power to regulate the procedure in an arbitration, and may fix the time and place of meeting, &c., though the invariable practice is to consult the convenience of the parties to the arbitration. An arbiter who has once accepted office cannot, unless he show sufficient reason, thereafter decline to proceed with an award, and, if necessary, the Court will order him to proceed. It has been held in England that an arbiter who refused to proceed to a final determination of the question referred to him was liable in damages. Where the reference is to two arbiters both must accept, since the reference is to the judgment of the two. But if one accept and the other refuse or die, or for any reason cannot act, the Court will fill up the vacancy. Arbiters have power, though not expressed in the deed constituting the reference, to appoint an oversman, and if they fail to agree, the Court may make the appointment.

An umpire or oversman is the person appointed to decide the question submitted to the arbiters in the event of their being unable to agree. He may be appointed either by the parties themselves in the deed of submission, or, as is more usually the case, by the arbiters. If the arbiters appoint, they ought always to do so before they enter on the reference; and in the case of statutory references under the Lands Clauses Acts this is essential. In choosing an oversman the arbiters must apply their minds to the question, and consequently a 'bare selection by lot cannot be supported. If, however, each arbiter exercises his judgment as to the fitness of two persons, and if they agree that both of these are fit and proper for the office, it is no objection that lots have been cast as to which of them shall be appointed.' The oversman acts only in the event of the arbiters differing in opinion. If the oversman die before a devolution take place, then the parties, the arbiters, or, in England, the Court, as the case may be, may appoint a new oversman. If, however, a devolution has taken place, and the oversman die before pronouncing an award, the parties may, if they agree, appoint a new oversman. But the arbiters cannot do so, for by the devolution their powers are exhausted. (See next article.) [D. B.]

Arbitration.—Arbitration is an agreement to refer to the decision of a neutral party—an arbiter (see preceding article)—some point which is undecided, or some difference which has arisen. Arbitration may be either general or a statutory arbitration under the Lands Clauses Acts, the Agricultural Holdings Acts, &c.[1]

ARBITRATION GENERALLY.—Anyone who can enter into a contract may refer to arbitration a matter in which he is interested, and practically any question in dispute regarding any property, real or personal, which may be the subject of a contract, may be submitted to arbitration. In the case of Scotch entailed estates, the right to refer is limited to statutory references. Questions of status, such as domicile, legitimacy, &c., cannot be referred. Provided the intention of parties be clear, no special form is necessary to constitute a submission. Consequently writing, strictly speaking, is not necessary, although to a proper submission writing ought always to be regarded as essential. The agreement to refer may concern a dispute in existence or possible future disputes, but in any event the only questions which can be determined are those relating to matters in dispute at the time of the reference, and not disputes arising subsequent to the date of the submission but before the award. Where the agreement to refer is constituted by a clause in a contract dealing with other matters, *e.g.* a contract of copartnery, the submission is in Scotland termed an ancillary one, and will cover only such disputes or differences as might reasonably be expected to arise from the nature of the contract. In Scotland, unless express power be given to the arbiter, he cannot assess damages arising out of a breach of the contract. The effect of an agreement to refer is that if either party raises an action against the other relating to a matter clearly falling within the scope of the submission, his action will be barred. The deed of submission may fix the time within which the award is to be made, and in such a case the arbitration falls *ipso facto* by the expiry of the date fixed without the issue of an award, and an award cannot be issued thereafter except by consent of the parties. In England, in the absence of express provision an award must be made within three months after arbiters have entered on the reference, but they may enlarge the time. In Scotland, if the deed states that the award must be issued before a date which is left blank, the arbitration will lapse by expiry of one year and day without the issue of an award; but if no date is fixed, nor any blank left, the arbitration will subsist for forty years or till an earlier award. Interim or partial awards cannot be made unless express power be given to the arbiter. Where such powers exist, care must be taken in making such interim or partial awards that the other matters in dispute are expressly reserved for further consideration, since otherwise the award may be taken as final, and the arbiters lose their power to deal further with the matters in dispute. If the submission be constituted by writing, the award, in order to be effective, must be in the form of a probative deed, and be delivered to the parties or their representatives or put on record. The award must exhaust all the matters submitted, and the failure to do so may be fatal. It must be certain, so as to obviate all doubts as to the parties' liabilities under it, and it must be possible of fulfilment. The award can be challenged on the grounds of corruption, bribery, or falsehood on the part of the arbiter or arbiters. It may also be reduced if it goes beyond the terms of the submission, if it is unintelligible, or if the arbiter has in any way failed to do even-handed justice between the parties. An error in judgment, no matter how great, does not form a sufficient ground for reducing a decree, unless unfairness on the part of the arbiter be shown.

STATUTORY ARBITRATION.—By the Lands Clauses Acts it is provided that where land is taken or injuriously affected, or any interest compromised by the action of the promoters, the compensation to be paid therefor may, if the claim exceed £50, be referred to arbitration. Under the Agricultural Holdings Acts, where a tenant claims compensation for improvements, for damage by game, or for unreasonable disturbance (1906 Act—after 1st January, 1909), and the parties cannot agree as to the amount, the difference must be settled by arbitration. The arbitration may, at the request of tenant or landlord, also extend to the determination of any claim for breach of contract or otherwise in respect of the holding competent either to landlord or tenant. Failing agreement either by provision in the lease or otherwise, the arbitration must, in terms of the Act of 1900, be before a single arbitrator; and it is provided by the 1906 Act (coming into force on 1st January, 1909) that notwithstanding any agreement to the contrary, all questions which are referred to arbitration shall be determined by a single arbiter. [D. B.]

---

[1] A matter in dispute in an action in Court may also be referred to arbitration by order of the Court.

Arboretum is the term ordinarily applied to any portion of a botanic or other garden or pleasure ground which is exclusively or mainly devoted to the growing of trees and shrubs for ornament. Thus, while a botanic garden is a living collection of trees, shrubs, and other plants arranged upon some definite plan (that usually followed being arrangement according to natural orders, sub-orders, genera, and species), an arboretum is a living collection of trees and shrubs intended either chiefly for ornament or else mainly for scientific purposes, in which latter case alone any attempt need be made to obtain systematic arrangement. The term has also, however, been applied in a figurative, still more loosely in an encyclopedic, sense, as in the Arboretum et Fruticetum Britannicum, the monumental work on trees and shrubs by J. C. Loudon (1838, 8 vols.; second edition, 1844; abridged edition, with different title, 1842). Such particular portion of the living collections under the keeper of a botanic garden are sometimes kept distinct, as in the case of the Arboretum adjoining the Royal Botanic Garden at Edinburgh, which was purchased by the municipality in or about the year 1887 in order to form a nucleus for the teaching of forestry. An arboretum includes specimens of all kinds of trees. Where the collection is limited only to Coniferous trees it is called a pinetum, and many fine pineta were formed throughout various parts of Britain, though especially in the central and southern portions of England (*e.g.* Syon House, Deepdene, Dropmore, and many places near London), during the second half of the 18th and the early half of the 19th centuries, when many importations of new genera and species were made from North America, the Himalayas, Australia, and elsewhere. The largest and by far the finest arboretum in Britain, and by many considered the finest in the whole world, is that contained in the Royal Botanic Gardens at Kew. It originated when the Duke of Argyll's pinetum at Hounslow, famous for its pines, firs, and cedars, was transferred in 1762 to the Princess of Wales's Garden at Kew. Including this arboretum, in 1841 the whole gardens extended only to 11 ac.; but they now amount to over 250 ac., 180 ac. of which are devoted to the arboretum. Next in celebrity in Britain come the arboreta at Edinburgh (Inverleith) and at Dublin (Glasnevin), the Botanical and various Collegiate Gardens at Oxford and Cambridge, and the Botanic Gardens at Glasgow. But almost every university has its own arboretum, and the municipal parks and pleasure grounds of many of our cities and towns are mainly treated as arboreta without striving after anything like being even partially complete collections of trees and shrubs. Some of these parks bear the special name of Arboretum (as at Ipswich, for example). The practical value of an arboretum is to afford proof of the ornamental qualities of trees and shrubs, and of their being able to resist the many variations of the British climate; and in this way they have been of undoubted use in adding to our knowledge, and of enabling landscape gardeners to improve the æsthetic effect when planting for ornament, both on large public and private estates, and in much smaller areas and humbler spheres. But beyond indicating the general hardiness of trees and their capacity for growing under the given conditions of soil and climate, arboreta afford little or no indication of the economic value of exotic trees for the growth of timber upon commercial lines. To obtain such data woodland experiments are necessary, and are alone reliable. [J. N.]

Arboriculture, broadly speaking, comprises everything relating to the cultivation of trees, without regard to any distinctions and differences. But it is now the term specifically applied to that branch of forestry (which see) which deals with the growing of timber trees either for profit or ornament (or both), and in which more particular attention is paid to the individual trees or groups of trees than is possible in sylviculture (which see) or the systematic treatment of woodland crops for the production of the most profitable return in timber or other forest produce obtainable under the given circumstances of soil and situation from the capital represented by the land and the stock of timber growing upon it. Thus, while the cultivation of fruit trees specially falls under horticulture (which see), the main difference between arboriculture and sylviculture is that when timber trees are treated arboriculturally, whether for profit or ornament (or both), economic principles are not so rigidly applied as is intended to be the case when sylvicultural treatment is adopted for growing timber or other woodland produce more or less strictly upon purely commercial lines.

The national system of forestry, which, owing to the early and extensive clearance of the English woodlands, gradually grew up in Britain during the eleventh till the sixteenth centuries, when it became enforced by the 'Statute of Woods' passed in 1543 to regulate the felling and regeneration of copsewoods or coppices, and which lasted from then right down to the end of the 18th century, was almost purely arboricultural; and even after the extensive planting of the larch (which see) and the Scots pine (which see) throughout different parts of the United Kingdom for profit, ornament, and shelter, from the middle of the 18th century onwards, the woodlands of all kinds continued to be treated arboriculturally rather than sylviculturally.

Hence down to the present day the vast majority of the three million acres classified as 'woods and plantations' are mainly treated arboriculturally for ornament, shelter, and game preservation, and are, fortunately for the beauty of our rural scenery, not worked systematically under cold, calculating, purely monetary considerations. And indeed the arboricultural method is not only that best suited to most British estates, but also in many cases the only one easily applicable to woodlands that are cut up into small blocks and patches, forming copsewoods and spinneys favourable to fox-hunting and game preservation; for in this respect there are much the same differences between arboriculture and sylviculture as between a small retail business and a great wholesale trade. Among European countries the most pronounced arboricultural system of forestry has for many centuries been followed in Britain, while the most systematic sylvicultural system has during the last 200 years evolved itself in Germany. These differences have arisen from local economic conditions. Throughout the whole of the United Kingdom, except in the woodland portions of tracts specially reserved as royal forests (which see), the original woodlands on all the tracts suitable for agriculture were for the most part cleared away at an early date; and Acts of Parliament had to be passed prohibiting further clearance, in order to maintain supplies of oak timber for shipbuilding and wood for other purposes. Almost the only great stretches of private woodlands which remained intact were the beech tracts on the chalk range in Bucks, Oxfordshire, and Gloucester, which have almost from time immemorial been treated more or less sylviculturally, the crop per acre over the whole area being for the local chair-making industry that ages ago gradually grew up there of greater importance than the production of fine individual trees. In Germany, however, the economic conditions were entirely different. Industrial development, phenomenal since 1871, was long so slow that when the economic value of the natural woodlands clothing the mountains, uplands, and great stretches of then thinly-populated plains began to be appreciated, the work of conservation had mainly to deal with the best way of introducing an organized administration of the vast supplies stored in the woodlands—now aggregating nearly 35,000,000 ac., mostly the free gift of nature—while regenerating, improving, and extending them so as to furnish *in perpetuo* the maximum quantity of timber, domestic fuel, and other produce, and the most profitable returns. Timber cultivation in France, well organized by Colbert in the 17th century, and further systematized by Napoleon's amended *Code forestière*, holds a place between the arboricultural method of Britain and the sylvicultural system of Germany; for although it is mainly sylvicultural both in principle and in practice, yet it aims rather more than does the German system at producing fine individual trees, and in affording a somewhat larger individual growing-space to these than is the prevailing practice throughout Germany. But the French thinnings are never as heavy as those that have long been habitual under the arboricultural methods obtaining in Britain.

Our methods, as already indicated, arose through the conditions obtaining even from early historical times. Clearance for agriculture and pasture must have taken place at a very early date, for large stretches of woodlands were already reserved as the 'royal hunting grounds' of the Saxon kings, and towards the end of the 7th century the West Saxon laws of King Ine imposed penalties on the burning of trees, their value being estimated by the number of swine that could find shelter under them. The first parliamentary enactment dealing with arboriculture was the Statute of Enclosure passed in 1482 in Edward IV's reign, when England was recovering from the destructive effects of the Wars of the Roses. It gave permission to landowners, possessed of woodlands that formed or had previously formed part of any royal forest or unenclosed chase, to enclose their woods for 7 years after coppicing the underwood, so as to protect the young flush of coppice shoots from damage by deer and cattle. By this time the copsewood system of growing oak and other timber trees as standards or overwood above coppice or underwood, periodically cut over from every 7 or 8 to 20 or 25 years, had become the national system of arboriculture for the growth of curved and crooked timber, oak timber in particular and for preference, then in constant demand for shipbuilding, and already becoming dangerously scarce. Previous to this, however, it had been customary to allow the enclosure of coppices for 3 years against cattle and deer.

But the growing scarcity of good timber 61 years later necessitated the passing of an Act for the Preservation of Woods in 1543, better known as the 'Statute of Woods', which applied to all woods in England, and was compulsory and prohibitive in its prescriptive clauses. This enactment was rendered necessary, as the preamble states, owing to the 'great and manifest likelihood of scarcity and lack as well of timber for building, making, repairing and maintaining of houses and ships, and also for fuel and firewood' throughout the kingdom. It ordered that from Michaelmas, 1544, onwards, 12 'standils or storers of oak' (or, failing oak, 'of elm, ash, asp, or beech') should be left per acre in all woods cut at 24 years old or less, and that such standard trees growing over the underwood should not be felled till they measured at least '10 inches square within 3 foot of the ground', under penalty of 3*s.* 4*d.* for every standard not stored or prematurely felled. It also provided for the 'enclosure and fencing for 4 years' of underwoods coppiced every 14 years or less, and for 6 years in the case of those cut over between 14 and 24 years of age, while copses with underwood over 24 years old were at each time of coppicing to be 'enclosed and fenced for 7 years'; and as regards standards 'weeded' or thinned out, 'for every acre so felled 12 trees of oak of the same such great trees' (or, failing oak, 'of elm, ash, asp, or beech') were to be left standing for the next 20 years, under heavy penalties for non-compliance. And the scarcity of timber, &c., is shown by the further command that no copsewood of 2 ac. or more in extent was, under penalty of 40*s.* an acre, to be transformed into arable or pasture land if ¼ mile distant from the owner's or tenant's house. But 'maiden oaks' that sprang up from seed were always selected for storing as standards in preference to stool-shorts.

It was in such scattered copsewoods, whose condition was thus determined and regulated by Act of Parliament, that the national 'arboricultural' system of timber growing in England, and after the Union throughout the whole of Britain, became developed. The first known plantation formed with live plants (and not merely by sowing or dibbling acorns) was the Cranbourne Grove in Windsor Forest, made about 1550 or 1560. The crooks and curved timber wanted for ships' knees, &c., could best be produced under such free isolation of the individual standard trees as copse growth gave, and similar conditions were even more completely attained by the raising of large quantities of oak, ash, and other hardwood trees as hedgerow timber, at a time when the wood and the bark far more than compensated for the shortage in the field crops and pastures due to the drip and overshadowing of the stored timber trees. A good idea of the method customary about that time is obtainable from The Boke of Husbandry, by Master Fitzherbert (1534), the first printed book in the English language treating of rural economy, in which sections 124 to 135 deal interestingly and instructively with the planting, tending, and plashing or 'pleching' of hedge fences, the planting and transplanting of trees, the setting of cuttings, the lopping and felling of timber trees and coppice, the selling of wood and timber, and the protection of 'spryne wodde' or flushing coppices.

The very stringent parliamentary prescriptions of the Statute of Woods, however, were successfully evaded as frequently as possible by landowners; and in a pamphlet (1613) called New Directions of Experience . . . for the Increasing of Timber and Firewood, by Arthur Standish, recommendations were for the first time made (as similar exhortations are still being made now, without any large measure of success) regarding the planting of waste lands with timber trees. The second edition of this (1615) was prefaced with a royal proclamation in which King James recommended that its 'severall good projects for the increasing of woods . . . be willingly received and put in practice', in order to supply the growing scarcity of timber throughout Britain. Much was done then and subsequently, both in the royal forests and by further enactments relating to the preservation of trees and the allotment and planting of commons, to stimulate arboriculture throughout Britain. In 1607 a simple, comprehensive working plan was drawn up for the management of the copses in the royal forests; and it was due to the action of the Navy Commissioners in appealing to the then newly founded Royal Society that John Evelyn's Sylva, or a Discourse of Forest Trees, was first prepared and read in 1662. But it is impossible to enumerate here even the chief of these various statutes; and in any case it was the Statute of Woods of 1543 which really determined and perpetuated the national form of arboriculture that still obtains throughout most English woodlands—the copse growth, where a sparsely scattered overwood of oak, ash, or elm chiefly, is grown above an underwood that is regularly 'coppiced' or cut back to the stool at fixed intervals (usually from 10 to 16 or 18 years), and where the standards generally form 4 or 5 age-classes corresponding to the multiples of the period at which the falls of coppice occur. The leading feature of this arboricultural system was the partial or complete isolation of the trees in order to permit them to form strong side branches, tough and durable in shipbuilding; whereas the sylvicultural system aims at producing long-boled, clean, straight trunks with a lofty and comparatively small crown of foliage. Trees of this latter class were not highly valued in the olden days of wooden ships, and in 1792 the special commissioners who reported to Parliament on the state of the royal woods and forests recorded their opinion concerning oak plantations made in the New Forest that 'the Trees were suffered to grow up so close, for want of proper Thinning, that few of them are likely ever to be fit for the Use of the Navy'. And this same idea prevailed with regard to all other trees, irrespective of their natural capacity for enduring shade and forming a thick crop, or requiring a somewhat large individual growing space, and therefore forming a proportionately thin crop with a more limited number of stems per acre. Hence, altogether without scientific basis, a very misleading rule was followed in practice that trees should usually be thinned to such an extent that the distance between trees should be about one-third of their height.

It is only from about 1890 onwards that such purely arboricultural methods have been giving place to the more scientific sylvicultural principles that have been evolved in Continental Europe, and in Germany in particular; but in general, British landowners, land agents, and foresters are still much in favour of somewhat heavy thinnings, which undoubtedly produce a more ornamental growth than the close canopy of woods treated purely sylviculturally. And it is certainly open to question if this arboricultural method is not in some cases (*e.g.* as in the production of pitwood props, for which the demand is very large) perhaps more profitable than any other system—a question which experiments alone can solve. The advancement of arboriculture and forestry forms the special aim of the Royal Scottish (1854) and English (1881) Arboricultural Societies, and the Irish Forestry Society (1901); but for more than a century this has also received great encouragement from the Highland and Agricultural Society of Edinburgh, and the Society of Arts, London, while more recently the Carpenters'

Company have offered special prizes for essays on the planting and management of woods. [J. N.]

Arboriculture, Statutes relating to.—Acts of Parliament relating to trees, woods, and plantations have been numerous since the Statute of Enclosure was passed in 1482, and the Statute of Woods in 1543 (see ARBORICULTURE); and this was especially the case throughout the 18th and early in the 19th centuries, when everything possible was done to encourage the planting of trees and to prevent their unlawful destruction. After the economic conditions necessitating stringent measures had become greatly altered by the opening up of our colonies and the improvement of communications by land and water, the various statutes regarding damage to woodlands, trees, and shrubs were in 1861 consolidated and amended in the Act . . . relating to Larceny, &c. (24 & 25 Vic. c. 96, s. 16, referring to 'any forest, chase, or purlieu', and ss. 31, 32, 33, and 35, referring to 'trees and woods'), protection being then also given to ornamental trees and shrubs under the Act relating to Malicious Injury to Property (c. 97, ss. 20, 21, 22, and 53). These statutes made it felony to steal any tree, shrub, or underwood, or to destroy or maliciously injure the same with intent to steal, if the value be £1 in parks, avenues, or pleasure grounds, or £5 elsewhere; and even if the value be only over 1*s*., on a third offence the larceny becomes a felony, and the malicious injury is then punishable with two years' imprisonment with hard labour. Until the passing of the Improvement of Land (Scotland) Act in 1893, Scottish landowners could only with the sanction of the Board of Agriculture charge their estates with the planting of woods and trees for the express purpose of shelter; but after 1893 sanction was obtainable whether the planting was for shelter or not. Under the Improvement of Land Act, 1899, which superseded the Settled Land Act (England), 1882, all the previous Acts throughout Great Britain were consolidated and amended; and sums borrowed may now be repaid by a rent charge extending to a period not exceeding forty years, the money expended on improvements and all expenses being chargeable in one sum on the estate.

Growing timber is under English law generally regarded as part of the estate in trust; and, as a rule, only oak, ash, and elm are by custom held to be 'timber' for this purpose, although local customs vary in this matter (and though the ancient prescriptions of the Statute of Woods, 1543, direct the storing as timber trees of 'elm, ash, asp, or beech', in default of oak in all copses); and money arising from the sale of timber is treated as capital, only the interest on its investment being paid to the owner in possession. Under Scots law, however, the owner in possession has an uncontrolled right to fell and sell, or otherwise dispose of, the timber. The rating of woods and plantations in Scotland is, under s. 6 of the Valuation of Lands Act, 1854, based on the yearly value, taken to be the rent at which the land in its natural state might reasonably be expected to let from year to year as pasture or grazing lands; and the principle is much the same in England, under ss. 3 and 14 of the Rating Act, 1874, although, if the land used as a plantation or wood, or for the growth of saleable underwood, be subject to common rights, it is exempt from the poor rate and other local rates.

The Finance Act, 1894, under which, at the death of each tenant, death duties are payable on the capital value of the property by the incoming tenant, has led to large falls of timber being made to raise part of the money required. To satisfy these requirements of this Succession Duty Act as regards the woodlands themselves, the custom in England is generally to value all the timber and other wood, and take 3 per cent of this as a fair annual return under good management. This income is then treated as an annuity, and succession duty is paid thereon upon a sliding scale (according to the age of the incoming life-tenant), as fixed in tables annexed to the Act. Protection against fire arising in woods or plantations from railway-engine sparks is only obtainable in the indirect form of damages (limited to £100) under the Compensation for Damage to Crops Act, 1905.

But although rabbits are the most destructive of all the enemies in Britain to ornamental trees, underwoods, and plantations of all sorts, yet there is no legal protection whatever against ground game; one must, if desirous of protecting one's property, either try the almost impracticable method of killing the destructive game as it comes on one's own land, or else adopt the expensive and by no means always successful system of wire-fencing all young plantations adjoining estates where rabbits or hares are preserved. [J. N.]

Arborvitæ, a sub-tribe of the Cupressineæ or Cypress group (which see) of the nat. ord. Coniferæ. The Arborvitæ sub-tribe differs from firs and pines in not having the branches disposed in whorls, though all are evergreen (except Taxodium), and consists of the five genera, Thuja, Biota, Libocedrus, Cyparissa, and Juniperus, mostly indigenous to north-eastern Asia, North America, and southern Africa, which are distinguished only by small differences. Our only native species is the common Juniper. All are evergreen trees or large shrubs, of a more or less fastigiate habit of growth and having a balsamic fragrance, which are chiefly cultivated for ornament. Their name of Arborvitæ, or 'tree of life', is derived from valuable medicinal properties having formerly been ascribed to the aromatic resin they mostly yield. Those generally cultivated in Britain are:—(1) The Common or American Arborvitæ (*Thuja occidentalis*) of Canada and the eastern States, introduced into Britain about 1566, which forms woodlands along with the American larch on wet, swampy tracts, where it grows up to about 80 or 90 ft. high and 6 to 12 ft. in girth. It thrives throughout the warmer parts of Britain in sheltered situations with deep, porous, fresh soil, and can be easily grown from seed or cuttings. (2) The Giant Arborvitæ or Red Cedar (*T. gigantea*) of British Columbia and north-western America, where it grows in the woods up to 5000 ft. elevation, and attains up to 100 ft. in height and 5 ft. in girth, and whence it was introduced in 1854. In Britain it can grow to 70 ft. by 6 ft. girth in 50 years, and has been tried as a woodland tree with more or less success. It does best on deep, fresh soil, and in a sheltered position, but is accommodating as to soil and hardy against frost. It has been found to grow well on lime, and on land that is too moist for larch. It produces seed here freely, and can be grown from seed or cuttings. It stands transplanting well, but does not grow so rapidly as larch, Douglas fir, or pine. (3) The Chinese Arborvitæ (*Biota orientalis*) of China and Japan has compact-looking, densely foliaged branches bearing rich deep-green foliage, but is only a shrub growing to about 20 or 25 ft. high. It prefers a dry soil and a sheltered position. (4) The Decurrent-leaved Arborvitæ (*Libocedrus decurrens*) of north-western America, ranging up to 140 ft. high and 15 ft. girth, grows here to 70 ft. high and over 5 ft. girth, and is quite hardy. [J. N.]

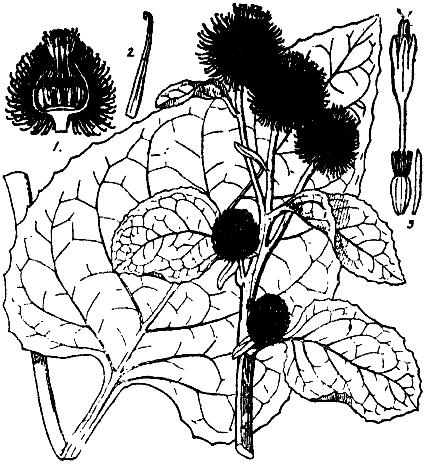
Archæan.—The earliest known rocks of the earth's crust form the Archæan group, in which are usually included all rocks older than the base of the Cambrian system. It is questionable if the primitive crust, before the formation of stratified deposits by denudation, is now known to us at any point. Even the 'Laurentian' rocks of Canada appear to be intrusive masses younger than the overlying Grenville series. But extensive pre-Cambrian sediments and metamorphic series have long been recognized, such as the Huronian or Algonkian of North America. The core of the Malvern range, the sandstones and conglomerates of the Longmynd on the Welsh border, and the area of old gneiss forming the Outer Hebrides, are examples of Archæan masses in Great Britain. [G. A. J. C.]

Architecture, Farm and Cottage. See BUILDINGS, COTTAGES, &c.

Arctia caja (Scarlet Tiger Moth).—This beautiful moth measures over 2 to 3 inches in wing expanse; the front wings are rich brown with some creamy-white markings; hind wings deep rich red, with orange tinge and rich purple-black spots, and red abdomen with median black bars. It occurs in gardens and lanes in July. The caterpillars called 'Woolly-Bears' live as small larvæ through the winter, and grow into maturity in June. They are black, with long, silky, whitish hairs on the back and rusty ones on the sides. They feed on garden plants and flowers, and often cause much loss to gardeners. When mature they spin a loose cocoon and change to a black pupa.

Treatment consists of hand-picking and spraying hardy plants with arsenate of lead. [F. V. T.]

Arctium Lappa (Burdock).—This is a coarse biennial weed of the natural order Compositæ, occasionally infesting neglected land, where it becomes troublesome; it is, however, unable to grow except in rich deep soils, and therefore is not wrongly regarded as a sign of good land. Its root is a fleshy tap lasting only for two years. The stem and all the foliage is clammy. The huge leaves are heart-shaped and coarse, with three strong ribs near the base, and a short hoary down on the underside. Each flower head is larger than a musket ball, and is surrounded by a scaly involucre of spiny-pointed scales, which, when ripe, become so hard and hooked that the whole flower head acquires the name of a bur, from its power of sticking to the clothes of the passer-by.



Burdock (*Arctium Lappa*)

1, Section of head. 2, Scale from involucre. 3, Flower and chaff scale.

Burdock is common on the neglected parts of farms, by roadsides, and on other places where weeds are allowed to grow unchecked. It is, however, easily extirpated by grubbing up before the flowering stage is reached. If deferred till a later period, the seeds ripen, and scatter about, thus producing a new race of the weed. [J. L.] [A. N. M'A.]

Are, the unit of the French land measure. It is a square of which each side is 10 metres in length, and it has therefore a surface of 100 sq. metres, or 1076·44 English sq. ft. The tenth part of an are is called a déciare, and the hundredth part a centiare. The déciare and centiare are thus respectively represented by squares of 10 and of 1 metre side. The only multiple of the are in common use in France is the hectare, which is equal to 100 ares, or to 2·47 English acres. In France, quantities of land are expressed in terms of hectares.

Areometric Beads.—Hollow glass beads of graduated densities, designed by Mrs. Lovi, of Edinburgh, in 1816, for ascertaining the specific gravity of milk. They are now of historical interest only, having been entirely replaced by modern forms of lactometer. The method was simply to ascertain experimentally which bead would float in the milk, the specific gravity being the relative number attached to that particular bead. A hydrometer is also called an *areometer*; hence the above name.

Argali, the largest wild sheep of the Altai and other mountain ranges in Central Asia. Central Asia is the home of a large number of different kinds of wild sheep, which differ from each other in size, colour, and in the length and curliness of their horns. Nevertheless they are all closely allied to one another, and in many cases it is doubtful if certain forms should be regarded as distinct species or merely as geographical races inhabiting different mountain ranges. One of the best and longest known of these is the Argali, which was named by Linnæus *Ovis ammon*. The typical form of this sheep formerly ranged in Siberia from the region of Lake Baikal to the Semipalatinsk plateau in the Altai. Adult rams stand about 46 in. at the shoulder, and the basal girth of the horns, which are unusually stout, is often more than one-third of their length along the exterior curve. The colour is greyish-brown, fading to white on the face, throat, and lower portion of the legs. The ewes are not much smaller than the rams, but their horns are short, slender, and only slightly curved. This sheep lives at various altitudes up to about 10,000 ft., and, like all wild sheep, is extremely wary and hard to shoot. This difficulty is increased by its habit of hiding in crevices between the rocks. In the winter, however, it not uncommonly becomes snowed up in the retreats where it has taken shelter, and thus falls an easy prey to the Cossacks, who have to a large extent exterminated the species in the eastern districts of its range. The typical Argali is represented in the Kuen Lun Mountains and in the Himalayas from Cashmere to Sikkim by a closely allied animal known as Hodgson's Argali (*Ovis ammon hodgsoni*), the rams of which have shorter horns than the northern race, and develop a white ruff on the throat. Very similar to this last is an Argali from the mountains to the north of Pekin, which has been called *Ovis ammon jubatus*. Usually regarded as a distinct species from the Argali is the wild sheep of the Saiar Mountains, in the Great Altai (*Ovis sairensis*), which stands about 38 in. at the shoulder, and is darker coloured, with the white of the muzzle sharply marked off from the brown of the face. On the other hand, Marco Polo's sheep (*Ovis poli*), from the Pamirs and Thian Shan, although only a little smaller than the Argali, has the horns longer and thinner, and is much paler below, the white extending from the hind leg right up on to the thigh, and from the belly nearly halfway up the side.

Argali (*Ovis ammon*).

In the direction and curvature of their horns, as well as in other structural characters, such as the presence of a preorbital gland on the face, these Asiatic sheep and others that could be mentioned are closely related to our domestic breeds, but it is not certain that any of them are concerned in the ancestry of the latter.

The true Argali of Central Asia must not be confounded with the North African wild sheep (*Ammotragus lervia*), which has been called the Bearded Argali, and is also known as the Arui, the Aoudad, the Algerian Mouflon, and the Barbary Sheep. In this species the horns, which are well developed in the female as well as in the male, do not form the bold close curvature of those of the Argali, but are directed upwards and backwards in an open curve, turning slightly inwards towards the shoulders at the tip. The tail, moreover, is longer than in any wild species of sheep, and is fringed in its lower portion with longish hair, sometimes falling below the hocks. There are also certain differences in the structure of the skull, such as the absence of a preorbital depression, lodging the facial gland, on the lacrymal bone, by which the African species may be distinguished from the Asiatic. The name 'bearded' has been applied to this species in allusion to the presence of a fringe of long hair which extends down the middle line of the throat. Hair of similar character covers the front and outer side of the upper part of the fore leg and falls well below the knee. This hair is peculiarly well developed in the male, but is also present in the female. The colour of both sexes is a uniform tawny brown, which shows no appreciable seasonal variation, and harmonizes closely with the prevalent tint of the reddish or sandy rocks amongst which the species lives. The Aoudad ranges from Morocco to Lower Egypt, and is the only indigenous sheep found in Africa. It does not, however, appear to have been domesticated at any period, and is certainly not one of the species concerned in the origin of any of our domestic breeds of sheep. [R. I. P.]

Argas reflexus (Fowl Tick).—This tick is sometimes found on poultry and pigeons. It attacks them at night, hiding away in crevices in the houses during the day. A fully distended female is $\frac{1}{3}$ in., the male $\frac{1}{6}$ in. The thin skin of the female allows the brown and violet tints of the organs to shine through, the margin is yellowish and a little raised; the surface is finely shagreened. The male is uniformly brown, the eight legs comparatively long. The larva has six longish legs, is round, and $\frac{1}{12}$ in. long. There are no eyes, the body in the genus Argas does not swell like that of other ticks. An allied tick, *A. persicus*, is the carrier of 'spirillosis' in fowls. Fowl Ticks are best cleared out of a dovecot or fowl run by fumigation with sulphur or hydrocyanic acid gas. [F. V. T.]

Argentine Republic, an extensive country of about 1,200,000 sq. miles in area, occupying the eastern side of the southern portion of South America, and stretching from the 22nd to the 55th parallel of south latitude. Chile separates it on the west from the Pacific Ocean; Bolivia, Paraguay, and Brazil bound it on the north; Uruguay and the South Atlantic Ocean on the east. Originally a Spanish colony, it is now a republic, with a constitution dating from 1853, on the model of that of the United States of America. Independence was proclaimed in 1810, and secured in 1816, but during the earlier half of the 19th century development of the country's resources was hindered by recurring civil wars, revolutions, and political crises.

Great variations in climate are found according to latitude, but only a relatively small portion in the north-west, bordering on Chile, suffers from deficiency in rainfall. Omitting this arid region and the heights of the Andes, the rest of Argentina forms an immense tract of land, whose future importance in the agricultural and industrial spheres requires to be reckoned with. The most important part of the country lies north of the 40th parallel of latitude and east of the 67th. Within these limits there is in general a sufficient rainfall for all agricultural purposes, the yearly supply ranging from 24 to 72 in., the wettest districts lying in the north-east. The rainy season covers the months from October to March, and the dry season from April to September. Near the eastern seaboard the rain is fairly well distributed through the year, but farther inland, either to north or west, the distribution follows the seasons more closely.

The people number over 6,000,000, and there is an annual addition by immigration from Italy, Spain, Austria-Hungary, Germany, and other countries, and to a less extent from Britain. More than three-quarters of the population are settled in the provinces of Buenos Ayres, Santa Fé, Córdoba, Entre Rios, Corrientes, and Tucumán, which either abut on or have comparatively ready access to the internal waterways furnished by the rivers which ultimately unite to form the estuary of the Rio de la Plata. The remaining provinces and territories, especially the three southern districts, are sparsely populated, and in the ten national territories a considerable proportion of the land is still in the possession of the government, to be sold or leased under specified conditions to meet the requirements of immigrants and others from time to time.

The religion of the State is the Roman Catholic, but all religions are tolerated, and freedom of profession and practice is secured by special articles in the constitution. Education is fully organized. There are three universities, several commercial schools or colleges, technical and industrial colleges, an agronomical and veterinary college, a school of mines, a school of vitiviniculture, several agricultural and pastoral schools, many normal colleges, national colleges or secondary schools, and a full equipment of primary schools.

The development of the mineral wealth, which is believed to be considerable, especially in the mountain regions, has hitherto been retarded by the want of ready means of transport. The lumber trade is limited by the comparatively small wooded areas, and the exports are chiefly quebracho logs and quebracho extract. In general the whole country is deficient in trees, and a stipulation to plant is inserted in the articles of sale of government land. and sometimes also in the bargains between shepherds and the owners of pastoral holdings. The great wealth of the country lies in its agricultural and live-stock products, and of these the former is now the more important. Subtropical crops are represented by tobacco, sugar cane, cotton, peanut, rice, castor, a native tea, mandioca (tapioca); temperate crops by wheat, alfalfa, maize, linseed, oats, potatoes, beans, peas, rye. Wheat is the most extensively grown, and the export of wheat is about 3,000,000 tons annually. A milling industry has sprung up, and flour, bran, and shorts are now also produced. Alfalfa or lucerne is said to come second in area covered, and there is a considerable export of hay, but this crop is of more consequence to the pastoral industry, and the extent sown is increasing very rapidly. Its use is rendering possible the utilization of lands worn out by unsystematic grazing, and also of areas too dry to furnish otherwise a full supply of pasture throughout the year. Together with maize, lucerne is relied on for the artificial feeding of stock where this is resorted to. Maize is, however, a most important crop on its own account, and in some seasons the quantity exported equals that of wheat, though its money value is somewhat less. Flax or linseed is grown solely for the seed, and the fibre is neglected, but it is naturally less valuable than that obtained when the plant is grown specially for manufacturing purposes. In 1906 the exports were:—

	Tons.	Approximate Value.
Wheat	2,247,988	£13,312,240
Maize	2,693,739	£10,673,140
Linseed	538,496	£5,183,180
Flour	128,998	£895,600
Bran	178,517	£650,000

Large flocks of sheep and herds of cattle and horses pasture on the rolling plains or pampas, and the pastoral industry is still the most important, as it is the oldest, though in the last three years the exports of live-stock products have taken a slightly lower place than the agricultural products.

Sheep were introduced from Peru and from Spain in the end of the 16th century, and rapidly increased; but they remained totally uncared for till the 19th century, when improvements were sought by the use of merinos imported from Europe and all countries where that breed had established itself. Up till the last decade of the 19th century the merino type prevailed, though practically every English breed had been experimented with. The Lincoln sheep were taken to Argentina about 1845, and slowly made their way until at present their type prevails, and the merino has been displaced to a great extent. A fall in the price of merino wool, their delicacy and tendency to foot-root, the development of a trade in frozen mutton—all served to accelerate the change to Lincoln which set in strongly, especially after 1884. English Leicesters, the Romney Marsh, and other long-wools have also been used to a limited extent. The Down breeds were introduced so long ago as 1825, but their smaller yield of wool restricts their use. The Shropshire is probably the best adapted of the short-woolled breeds, but Oxford and Hampshire Downs are also found.

Wool was formerly the sole, and still remains the greatest, source of income to the Argentine sheepowner. In 1843 the industry of boiling down fat sheep for their hides, fat, bones, and glue was introduced, and proved a most profitable outlet for the surplus stock till about 1882, when the fall in the price of tallow and skins greatly reduced the returns. In 1883 commenced the export to Europe of frozen mutton, a trade which has now attained enormous proportions. The exports of sheep products for 1906 were—

	Tons.		Approximate Value.
Wool	149,110	...	£11,680,600
Sheepskins	23,781	...	£1,702,800
Frozen mutton	67,388	...	£1,080,000
Tallow	25,301	....	£700,000

The original stocks of cattle were derived from Peru and from Spain, but, as with sheep, improvement was brought about in the 19th century by importations from Europe. Wherever the conditions of climate and pasture are favourable, the Shorthorn has been, and still remains, the favourite, either for crossing and grading up, or as a pure breed. Argentina is one of the greatest markets for the pedigree stock of British Shorthorn breeders, and very high prices have been paid for animals with suitable colour and other characteristics. French Shorthorns and the polled Durham variety are also found to a limited extent. Ranking after the Shorthorns come the Hereford and Aberdeen-Angus breeds, which are regarded as better adapted for districts with less favourable natural conditions. Holstein, Dutch, Flemish, Swiss, and other breeds are likewise used. Within the last few years the dairying industry has been greatly developed, and Argentine butter has acquired a very high reputation in the British market. Most of the milch cattle are of Shorthorn grade, though practically all the European dairy breeds have been, and will probably still be, drawn on to strengthen the milk-producing qualities.

The exports of cattle products in 1906 were—

	Tons.	Approximate Value.
Cattle hides (dry and salted)	56,076	£4,000,000
Beef (frozen and preserved)....	166,180	£3,520,000
Butter	4,405	£352,500

The horse-breeding industry has not been so fully organized as in the cases of cattle and sheep, and so far it is the least profitable of the three common branches of stock farming. The original stock was derived from Spain and Peru, and at a very early date had Barb and Arab blood added. At present the breeds kept or used for grading include—Clydesdale, Hackney, Shire, Yorkshire, Coaching, Percheron, Thoroughbred, Arab, and others, but so far the export of horses has not attained the position of a steady and satisfactory trade, and the reputation of Argentine horses does not stand very high. Horses are kept in many pastoral districts to keep down the coarser pastures and improve the feeding for other animals following. The export of horse products in 1906 were—

	Approximate Value.
Horse hair	2,250 tons; £250,000
Horse hides (dry and salted).	250,307 tons; £115,340

The export trade in living animals is subject to fluctuations arising from restrictions imposed when occasion demands, to guard against the spread of foot-and-mouth disease and other contagious disorders. A comparison of the figures for 1905 and 1906 serves to illustrate this point, for a decree of April, 1906, prohibited temporarily the export of live stock in consequence of the existence of foot-and-mouth disease in certain districts of the republic.

	Numbers Exported.			Approximate Value.	
	1905.	1906.		1905.	1906.
Cattle......	262,681	71,106	...	£1,033,000	£335,430
Horses, Asses, and Mules	61,358	38,184	...	£332,500	£214,600
Sheep......	120,166	102,916	...	£73,000	£63,080

The total external trade of Argentina is very considerable. Its best customers are the United Kingdom, Germany, France, and Belgium, and its purchases are made chiefly from the same countries and from the United States. The value of the 1906 exports was approximately £59,000,000, and of the 1906 imports £54,000,000. The imports consist chiefly of textiles (raw and manufactured); iron and steel goods; machinery for locomotion and conveyance; machinery for agriculture; foodstuffs; stone, clay, and glass ware; liquors; chemicals; tobacco; live stock. The internal traffic is largely borne on the tributaries of the Rio de la Plata, with the assistance of fully 12,000 miles of railways, which latter carried about 30,000,000 passengers and 26,000,000 tons of freight in 1906. The national revenue for 1906 amounted to £11,566,000, the expenditure to £5,000,000. The external debt is about £77,000,000, the internal debt £8,250,000. [J. ST.]

Argillaceous Earth. See CLAY.

Argyresthia conjugella (Apple and Roan Tree Fruit Moth).—The caterpillars of this moth (which belongs to the clothes-moth group Tineinæ, and to the family Argyresthidæ) feed in the fruit of apple and plum, also mountain ash, tunnelling small galleries in it, and so cause decay. The moth appears in May and July. It is nearly half an inch in wing expanse; the front wings are brownish with purplish sheen, the inner margin creamy-white, interrupted by a brown spot, and with two pale spots towards the tip; hind wings grey with long fringes. The larva is dull-yellowish to pinkish-white, with dark head, second segment, and tail. It destroys the pips of the fruit. It is fairly common in England, especially in mountain-ash berries, but is more destructive to apples on the Continent than here.

All diseased fruit should be collected and burnt. Early arsenical spraying is said to be beneficial. [F. V. T.]

Argyresthia ephippella (Cherry Fruit Moth).—This is a small moth, also belonging to the family Argyresthidæ, which measures less than half an inch across the wings; fore wings pale-brown, with white inner margins interrupted beyond the middle by a dark-brown spot, which passes across the wing as an oblique band, terminating on the costa. They appear in June and July, and when at rest assume a characteristic attitude, looking as if resting on their head. The eggs are deposited on the cherry shoots, near flower buds, and remain all the winter; they hatch out in spring, and crawl to the blossom just as the fruit is forming; the caterpillar has sixteen feet, the colour pallid-green, becoming grey, with brown head and first segment. They enter the small fruitlets, in which they lie curled up for seventeen days scooping out the inside. The pupal stage is passed in the dead fruitlet in a dense white cocoon, from which the moth escapes in about two weeks.

Nothing has been tried as a preventive, but probably a good spraying with arsenate of lead just before the blossom shows, and again when it has fallen, would check the damage. This pest has been described under the name *A. nitidella*, which occurs in the shoots of hawthorn in May. [F. V. T.]

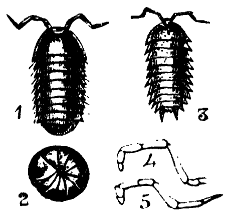
Aria. See Service Tree.

Arid Lands. See Alkali Soils and Deserts.

Arion, a genus of slugs, of which the well-known black slug, *Arion ater*, is perhaps the most familiar example. Other two common species are *Arion flavus*, Muller, a grey type which is widely distributed in Britain, and *Arion hortensis*, a form which varies in colour from black to grey, yellowish, or brown, and is usually longitudinally striped. Arion lives in damp, shady regions, such as woods, ditches, and gardens, all over Britain. The genus is vegetarian, and in gardens these slugs are very destructive. *Arion ater* has been proved to be omnivorous in diet, eating earthworms, insects, and even members of its own species. It breeds in May and June, laying its eggs in holes, under stones, and other concealed places near the roots of plants. A claret-coloured variety has been described from pine woods. Arions, when at rest, contract their bodies into a helmit-like mass. For methods of dealing with this pest see art. Slugs. [J. R.]

Aries. See Earnest.

Armadillidium (Pill Woodlice).—These woodlice are easily told by the complete way in which they roll themselves up. They are locally known as 'monkey-peas' in Kent, also as 'hog lice', 'armadillo lice', 'sow bugs' (Berkshire), 'cudworms', 'chiselbobs', &c. Four species occur in Britain; the commonest is *A. vulgare*, the common pill woodlouse, with smooth, shiny, strongly arched, slaty-grey body, often with yellow markings. It rolls itself into a perfect sphere. They have no projecting tail appendages when walking. These small land Crustacea live in damp places and feed upon all manner of substances, and attack plants, especially seedlings. They lay their eggs in summer, which they retain in a brood pouch, where they develop. The young are like the parents. Growth is accompanied by a moulting of the skin. They are best trapped by damp moss, horse dung, and wet sacking, and may be killed in greenhouses by fumigating with hydrocyanic acid gas. [F. V. T.]



Woodlice

1. Armadillo vulgaris; 2, Porcellio scaber; 3, A. vulgaris; 4, Antenna of Oniscus; 5, Antenna of Porcellio.

Army Horses.—The value of an army depends, to a large extent, on its mobility, and increases in direct proportion to the extent to which such mobility can be split up. The ideal may be said to be attained when each unit, as represented by one man, is furnished with the best possible means of rapid movement, under all exigencies of circumstances, from one strategical spot to another. In the days of Xenophon a horse was considered the ideal method of fulfilling mobile requirements. To-day the position is still unchanged. Mechanical methods of locomotion have not displaced him. He is still an absolute necessity for military purposes amongst every nation, savage or civilized, in the world, whether used for purposes of draught or saddle.

All through the various ages differing methods of warfare have from time to time required varying types of horses. In the days of armour for man and horse a good-sized Shire was not a bit too big to carry the weight required. Gradually from then until the present day there has been a tendency to reduce the weight to be carried. Armour is a thing of the past, the only remaining relic of it in this country being the cuirasses worn on parade by the Life Guards. Accoutrements and arms are less cumbersome. With the decrease of weight there has come a better-bred class of horse, capable of standing greater fatigue, of carrying more weight in proportion to his size, and possessed of far greater speed. At the present time the work required of the army horse, being of such a varied character, naturally calls for a similar variation in the type of the horse. Briefly they may be divided into those required for the purposes of saddle and draught, with further subdivisions of each. Thus the saddle horses are divided into those suitable for heavy and light cavalry, while the draught horses are classed as wheelers and leaders in gun teams, and those suitable for the transport work of the Army Service Corps.

In times of active and foreign service the accepted types used at home for the above purposes are not always strictly adhered to, from force of circumstances. This is partly due to regiments not always taking their horses with them, possibly on account of their not being always suitable to the exigencies of the climate, or to a deficiency in the requisite number. Fresh mounts are therefore furnished on arrival, which may, quite likely, differ entirely from what the regiment has been used to. Again, many more horses are required in time of war than in peace, and losses from sickness or in action have to be made good with the best that it is possible to obtain at the time.

Army horses are bought as near to type as they can be. Nothing looks worse than to see a regiment mounted on horses showing all manner of makes and shapes. They must be sound, not necessarily good-looking, their feet and legs must be of the best, and they should be of a good whole colour (a washy-coloured horse is invariably a bad doer). They ought to be round-barrelled, well ribbed up, good-couraged horses, straight clean goers, and not more than five or six years of age when drafted from the remount depot.

The troop horse, such as is used in the Life Guards and Scots Greys, should be as much after the stamp of the well-bred heavy-weight hunter as the price allowed for his purchase will permit. He should be not less than 16 hands high, well bred, with a fair length of rein, good back and middle piece (a slight extra length of back in a charger is forgiven, if not excessive, since he carries the appointments better). The loins must be strong and well ribbed up, that is, the last rib should be close to the angle of the hip. He must have a good riding shoulder, with a corresponding slope of the pastern, and should be short between the knee and fetlock. The knees and hocks should be large, and there must be plenty of bone below them. The width between the fore legs should not be excessive, but sufficient to prevent brushing, and he should be a clean goer behind. The feet must be well formed, not too thin at the heel, and should be a pair; the frogs should be well developed, the sheath large, and the anus prominent. The quarters should be well made, fairly flat, and the tail set on high up.

Good whole colours are preferable; greys are allowed only in the Scots Greys. Another regiment tied to colour is the Life Guards, who are always mounted on black chargers. He should be quiet to ride, and of a good temperament, undocked, a good doer, and well up to the weight to be carried, which is often 18 to 20 st.

The light troop horse is more of the type of the light-weight hunter, but, as a rule, he has to carry a good deal more weight, with this difference, however, that it has not to be carried on all occasions, or over fences, or at the same rate of speed as a hunter; still, the so-called Light Cavalry man with full equipment will often ride 16 st.

His mount, therefore, must be well bred, with a good carriage of the head and neck; the shoulders should be lighter than those of the heavy troop horse, well sloped, and with the fore legs well put on. This type of horse must be particularly handy, and have a fair rate of speed, and unless he has the right sort of front on him, he will not possess either of these qualities. There must also be a good girth in front, and a fair depth of loin, and he should be well ribbed up. The hips must not be too wide, the thighs and gaskins should be muscular, and the hocks fairly straight and not too far back. Curly or sickle-shaped hocks are useless, and the shorter he is on the leg the better he will wear; his height should not be less than 15 hands 2 in.

Of late years another type of troop horse has sprung into existence, namely, the Mounted Infantry Cob. This sturdy little trooper should stand about 14·2 to 14·3 hands high, on short legs, with good feet. A slight shortness of neck and thickness of shoulder may be forgiven him, since he has to carry more in proportion to his size than either of his brother troopers. He must, however, have a good slope to his shoulder, and should be short in the back, with strong loins and good quarters. He can hardly have too much bone, and he need not be very fast, but he must be a good stayer and a hardy doer.

The draught horses are used in the Royal Horse and Field Artillery batteries, and in the Army Service Corps. Those in the wheel of the gun teams should be short-legged, active, quick horses, with sufficient weight to stop the gun smartly. As they have to gallop at times, they must not be too straight in the shoulder. Their hocks must be large, well made, and sound, as their work entails a very heavy strain on them. The centres and leaders are of a lighter stamp, resembling the light vanner of the Metropolis. They need not have so much bone as the wheelers, and should be lighter in the shoulder, and this especially applies to the leaders. In manœuvring with the guns, they have to cover more ground than the others, and must be especially quick in getting away. Those artillery horses not used on the guns are of the Light Cavalry type. The signalmen attached to Field Batteries usually ride cobs of the Mounted Infantry type.

The gun teams of the Royal Horse Artillery, having to manœuvre with cavalry, should be of a slightly better 'class' all round than those of the Royal Field Artillery. They may be somewhat lighter, especially the wheelers, and must be particularly active horses and able to gallop; the average height should be about 15 hands 3 in.

In the Army Service Corps, most of the horses are of the heavy van type, from 15·2 to 16 hands high; but since all have on occasions to trot, they must not be too straight in the shoulders; they should have plenty of bone, and good feet.

In India nearly all the service horses come from Australia, and are known as 'Walers'. More or less well bred, particularly hardy, they do their work well, and stand the ravages of a hot climate better than the English or Irish bred. They are big upstanding horses, with good bone, and the best of shoulders; they are extremely handy, pleasant to ride, and very sure of foot in crossing rough ground. They do best when brought over young, about 4 years old, and allowed a couple of years in which to acclimatize before being put to really hard work.

A good type of pony, that came to the fore during the South African War, is the Basuto; his average height is not more than 14 hands, yet he will carry 12 to 14 st. all day, with a minimum amount of food. He is a particularly compact, well-made little horse, showing a good deal of the Arab in his quarters. His hardiness, handiness, and size make him an ideal Mounted Infantry cob. See art. BASUTO PONIES.

Army horses when in barracks are housed in long troop stables, in either single or double rows. The better stables are open-roofed, and have a window high up, between each two horses, and large sliding doors at each end. There are no stall divisions, their place being taken by swinging bails, which should be suspended from the roof, and not from a heel post behind. During the daytime the litter is all taken outside, well shaken up, and placed under the litter sheds to dry, the horses standing on the bare floor. This plan has its advantages in economy of litter and a tendency to keep the feet cool, the usual cement or stone flooring being a good conductor of heat, which straw is not.

Another advantage from a military point of view is that, on entering a troop stable, every horse and man can be seen practically at once. Its disadvantage lies in the lack of adequate protection against kicking. To guard against this, it is well to have a second smaller bail, hanging from the ordinary one so as to clear the floor by 2 or 3 in. Bad kickers occasionally get their legs over the bails and have to be released by the stable guard. Another advantage of bails is the help that they afford to cleaning operations and ventilation, there being practically no obstruction to sweeping or to currents of air.

As a general rule, army horses are not clipped, and when stabled do not wear any clothing. Of late years, however, in some batteries of Artillery the horses are all clipped and their manes hogged. If the stables are exposed they are generally clothed after removing the coat, but in warm stables rugs are, as often as not, dispensed with. Officers' chargers are not stabled with the troop horses, but are accommodated either in boxes, or in a separate stable with bails, by themselves. They are usually clothed, and are attended by grooms told off for the purpose.

When in camp or on active service, the horses are kept in 'lines', a maximum width of space of 6 ft. being allowed to each; he is secured by a head rope from the headstall to the head line, and a heel rope from the hind leg to the heel line. By this means the horses are kept straight, and, as far as possible, prevented from kicking each other. When the weather requires it, they are provided with rugs.

The food for army horses is dependent on the country they are in, and the season of the year. At home they are fed on oats, hay, and bran, with an occasional variation in the shape of carrots and green fodder, according to the season. The ration in times of peace is 10 lb. of oats and 12 lb. of hay, and a little rock salt; 1 or 2 lb. of bran may be substituted for a similar quantity of oats if desired. Part of the hay may be cut into chaff and fed with the corn, the remainder being fed long. This is not an extravagant ration by any means; it is sufficient when the work is light, but is not enough to keep horses in good condition in times of war, when manœuvring or living in the open, with the possibility of cold wet weather. The allowance of hay could well be increased to 16 lb. per day. The ration usually works out fairly well over a large number when well looked after. In almost any squadron or battery there are always some horses that appear to do well on anything, or very little, so that by carefully regulating the feeding good results can be attained. Regularity of feeding is a great aid to economy of food. The allowance of straw for litter is 6 lb. per horse per day.

In times of war, and when on manœuvres, the ration is increased up to 16 lb. of oats, the hay remaining about the same. This is, of course, subject to alteration in war time, depending on what is obtainable. When a sudden change of food is necessary, great care should be taken not to feed too heavily at first. The times of feeding are 5.30 or 6 o'clock in the morning, midday, and 5 o'clock or 5.30 in the evening. The horses are watered at troughs in barracks and in camp, and fed immediately after; the hay is best divided up into two or three feeds and given about one hour after the corn.

The supply of horses for army purposes is hardly up to the demand in this country. Most regiments are short. Ireland furnishes a good number, and all the leading fairs in England and Wales are also attended by buyers on the lookout for likely animals. When purchased they are sent to the remount depots, to be got into shape, and from there are drafted to the various branches of the service, where their education is completed. One great advantage that army horses have, over the majority of their brethren in civil life, is that a great part of their education is given in the riding school. The value of a school for teaching purposes is in its quietness. It is shut off from all outside disturbing influences of sight and sound, which might otherwise cause the pupil's attention to wander. Thus his attention remains undivided, and the lesson is indelibly printed on his memory. School work does horses, and men as well, a great deal of good. It brings a horse under absolute control, and prevents him from taking the initiative, as it were, which is the last thing an ideal cavalry horse should do; he may be prepared for it, but, in order to obtain uniformity of movement, it is the prerogative of the rider to give the signal. It is beneficial to the rider, in that it teaches him the technique of every movement of the horse, and the correct method of ensuring its proper performance. To many horsemen this comes naturally; but how many others are there who know how to make a horse lead off with the right leg, in a canter, for instance?

When a horse enters the 'service' he is branded with his number as a remount, and later with his regimental one, on the feet. The age, sex, colour, and markings are entered on a printed form called a history sheet; this accompanies the horse wherever he is stationed. There is entered on it from time to time a complete history in brief of every ailment that has incapacitated him for duty, with the dates of attack and return to duty. Thus a valuable veterinary history of every horse in the service is available at a moment's notice.

Sick lines, and hospitals for purposes of isolation and treatment of disease, are found in every barracks, and temporary ones are constructed in every camp when necessary. They are under the charge of the departmental veterinary officers, assisted by the farrier sergeants and their men.

A system has now been in vogue for some time by which horse owners having suitable animals are enabled to register the number of horses in regular work which they could supply at once, if urgently requisitioned by the Government, the owners receiving a small sum per annum for each horse, in consideration of their undertaking. This system worked very well in the last South African War, when numbers of London omnibus and tram horses found their way to the front, and, on account of their hard condition, acquitted themselves well.

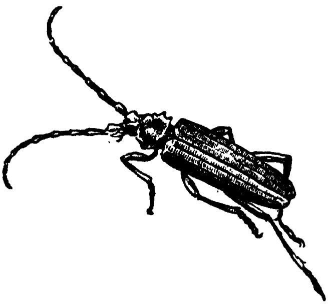
In times of war, when large numbers of horses are required at a very short notice, the remount department is taxed to a very high point. If the seat of war is far distant, the difficulties are much increased. The trouble does not consist of finding the horses—there are plenty of suitable horses in the world; in Australia, and North and South America, to say nothing of those to be bought in Great Britain and Ireland. But they are not 'fit'; as a rule they are running at grass, and in the ordinary course of events would not be ready for the hard work of a campaign for at least three or six months. Yet such horses are hurried away within a few days of landing, if they have been previously broken, and are obliged to perform long marches, carrying heavy weights. It is therefore not greatly to be wondered at that but few survive such unreasonable treatment. Large numbers are incapacitated from laminitis (fever in the feet), brought on by severe exertion, suddenly called for, after a prolonged period of inactivity, and standing on board ship. The sudden change of food is also a strong predisposing factor. It is unreasonable to expect horses to suddenly adapt themselves to such sudden changes.

In the South African War the waste of horse flesh was appalling, simply from the want of condition, which time absolutely forbade. Thousands of horses never reached the front at all; they were physically unable to get there. The Boers, on the other hand, had no such difficulties to overcome. With the exception of the Stadts Artillery, every man brought his horse, and, since he was going to risk his life, it was probably the best and fittest he had. In addition to this, his mount was thoroughly acclimatized, and did no more work than he would in all probability have been required to do at home.

The fact that so many of our best horses are constantly leaving the country to horse the cavalry of other nations is greatly to be deprecated. We require them all; and until this is put an end to, and some method of State breeding studs adopted, it is to be feared that there will always be a certain shortness in the supply of suitable horses for army purposes, and more especially in times of emergency. [G. B.]

Aroma is the term generally applied to an agreeable odour. It is a property possessed by many plants. Some herbs in particular become of commercial importance because of the presence in them of substances possessing a fragrant smell. These substances are definite chemical compounds, and are often derivatives of an important class of organic bodies called aromatic. Some are extracted from plants and used as perfumes.

Many of the farm crops possess distinct aromas. So definite and familiar are they, that a turnip, swede, carrot, bean, and a great many other plants may be at once recognized as such when close enough to smell. Aroma is, however, a property which lends itself little to a suitable definition, although it is something very definite and characteristic. A good sample of butter or a well-ripened cheese possesses an aroma which all good judges have no difficulty in recognizing; in fact a cheese is material which has the power of developing an aroma peculiar to itself, and it is in the recollection of the smell or taste of this aroma that we recognize the substance called cheese. To a person highly sensitive and carefully trained to detect small changes in the character of aromas arising in vegetable or animal substances from different causes, the faculty of discrimination becomes a possession of commercial value and utility. [R. A. B.]

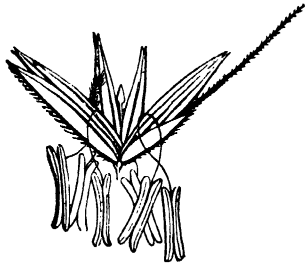


Musk Beetle (*Aromia moschata*)

Aromia moschata (Musk Beetle).—A handsome beetle 1½ in. long, bright metallic green to coppery or bluish, with long antennæ, slightly shorter than body in female, 1½ times as long in male. It receives its name from diffusing an agreeable musky odour. Its larvæ are soft, white, and fleshy, somewhat flattened and widened anteriorly, with six minute legs in front. They live in the trunks of willows, boring into the heart of the trees, and as they live for some years they do much damage. Sound as well as decaying willows are attacked. Pupation takes place in the wood. Attacked trees should be cut and burnt in winter to prevent the pest spreading. [F. V. T.]

Arpent.—An old unit of area used in France before the metric system came into vogue. The area which was represented by 1 arpent was not a constant quantity, varying even in closely adjoining districts, and was thus a source of great confusion in the sale and transfer of land. In most cases an arpent represented 100 square perches, but the linear perch was of varying length. Thus the Parisian perch was 18 ft., so that the Parisian arpent contained 32,400 sq. ft.; the ordinance perch contained 22 ft. and the arpent 48,400 sq. ft.; the common arpent had 40,000 sq. ft., represented by a square of side 10 perches of 20 ft. each. [J. B.]

Arrhenatherum.—This genus of grasses belongs to the division with two-flowered spikelets, whose glumes are as long as the pales, and the lower pale is furnished with an awn, both twisted and kneed. Among such plants it is known by the lower of the two florets being male, with a long twisted and kneed awn at the back of the lower pale, while the upper floret, which is hermaphrodite, has a very short straight awn on the pale. The difference in the sex of the two florets affords a clear mark of distinction for this genus.



Spikelet of Tall Oat Grass

1. *A. avenaceum* (Tall Oat Grass, French Rye Grass, Common Oat Grass).—This plant, which is also called *Avena elatior*, is a perennial fibrous-rooted, loosely tufted plant, with dark-green roughish leaves, and a slender, smooth stem about 3 ft. high, terminated by a panicle of satiny pale-green, often directed a little to one side. The conspicuous awn of the lower floret gives an oat-like appearance to the ear of plant, hence its common name. Linnæus, indeed, looked upon it as an oat; and like that genus, this has the grain adhering to the pales. The plant is found very generally in pastures and hedgerows, but not in considerable quantity. It flowers in June, and ripens in July. The herbage is copious, especially in autumn. In certain districts of France and other parts of the Continent this is one of the most extensively cultivated grasses, and in Britain it is now beginning to receive attention on account of its special suitability for producing hay and pasture on light land. It possesses the desirable properties of speedily attaining to maturity from seed, and of yielding continuously from early spring till checked by winter frosts a large bulk of produce, particularly on dry arid soils. In its natural range of growth this grass is found only on dry soils, either shaded or exposed, and that most abundantly under altitudes of about 1000 ft., on steep and rugged hillsides, banks of ravines, and among rocky debris. For sowing alone 38 lb. pure germinating seed are sufficient, and for sowing in mixtures the amount of seed required may be calculated on the basis that 50 lb. of pure germinating seed are required for the whole acre. The quantity of seed to be included in a mixture might vary from 5 to 10 lb. per acre, which would be sufficient to cover one-tenth or one-fifth part of the whole area. One lb. of pure seed contains 159,000 grains. The weight per bushel is about 10 lb.

The seed is readily distinguished from that of all other grasses by its large size, and by the presence of two awns, one very long, the other very short.

2. *A. bulbosum*, or *A. avenaceum*, var. *bulbosum* (Bulbous Oat Grass, Pearl Grass, Onion Couch, or Knot Grass), is a variety of the last, with the base of each stem enlarged into superposed bulbs, or rather corms, filled with starch and some essential oil. The joints along its stem are hairy, and not bald as in the non-bulbous variety. The corms, which are easily separable, can multiply the plant extensively, and so this is apt to become a troublesome light-land weed, difficult to extirpate even with the best tillage.

The seeds themselves are easily dispersed to great distances by wind, and grow with great facility. To extirpate the Bulbous Oat, the most efficient mode is carefully to hand-pick the roots, *i.e.* the corms, when the ground is harrowed at the sowing of corn, and during the preparation for fallow crops. The strawyard, barn, and manure heap must also be so managed as to prevent the seeds being returned in a vegetative state to the fields. [J. L.]
[A. N. M‘A.]

Arrowroot.—Formerly the term ‘arrowroot’ was applied to the starch obtained from several species of the genus Maranta (order Cannaceæ). At the present time the arrowroot of commerce is derived from a number of genera in addition to the one mentioned: for example, Queensland arrowroot, obtained almost wholly from the allied *Canna edulis*; East Indian arrowroot, from the rootstocks of *Curcuma angustifolia* (of the ginger family); and Brazilian arrowroot, prepared from the Cassava or Manihot roots. In the West Indies, where the best arrowroot is produced, practically the whole source of supply is *Maranta arundinacea*, L.

In the cultivation of this plant, loose loams or sandy soils are the most suitable, and give *the highest return per acre. After bein thoroughly cleared of all weeds and bush,* tl land is well manured and ploughed deep, and after being harrowed, is laid out in drills. Th drills are about 6 in. deep, and the 'sets planted about 8 to 9 in. apart, while 3 to 4 ft separate adjacent rows. In each hole a piece of old rhizome having two to three joints is placed, and the soil afterwards smoothed over by harrowing. Catch crops of maize, potato, &c., are often planted between the rows. After planting, the ground requires to be carefully weeded, generally at intervals of five to six weeks, and it is not for ten to twelve months after planting that the roots have developed their maximum amount of starch and are ready for gathering.

Arrowroot (*Maranta arundinacea*)

In the Bermudas, where arrowroot fetching the highest price in the English market is produced, the extraction of the starch is conducted with great care and cleanliness. After collection the roots are thoroughly washed to ensure perfect freedom from adhering particles of soil, and the skin completely removed with suitable knives. This removal of the cuticle is essential if a high quality of arrowroot is desired, as the skin not only tends to discolour the starch produced, but also, owing to the presence of resinous matter, imparts to it a disagreeable flavour. After removal of the skin the roots are again carefully washed, and afterwards crushed between copper rollers. The pulp is then transferred to large cylinders provided with small perforations, where it is thoroughly agitated and treated with a current of water. The starch is thus separated from the woody fibre, the milky-looking liquor issuing from the cylinders containing the greater part of the starch present *in the roots. To separate the remaining small quantity of fibre, the liquor is passed through* fine muslin sieves, and *afterwards allowed to* settle in suitable reservoirs, where it is repeatedly washed with fresh *portions of clean water* after each settling. After this careful washing the starch is transferred to shallow copper pans, which are then covered with fine white gauze to exclude all dust, and whence, when dry, it is packed into small barrels for shipment.

In the West Indies the average yield is from 6 to 7 tons per acre of roots, which would give roughly 22 to 23 cwt. of the air-dried finished arrowroot. In Queensland, where large acreages are devoted to the cultivation of *Canna edulis*, higher returns are obtained, and crops of 20 tons per acre are not uncommon.

Very few published analyses of the roots of *Maranta arundinacea* are available; but one made by E. Leuscher (Journal of Chem. Soc., May, 1902) gives the following as the average composition of roots grown in Jamaica:—

Water	63·42 per cent
Starch	27·84 ,,
Dextrin and sugar	2·08 ,,
Crude fibre	3·94 ,,
Ether extract	0·19 ,,
Proteid	1·64 ,,
Ash	0·89 ,,

The following are analyses of arrowroot starch quoted in Journal of Jamaica Agricultural Soc., 1906, vol. x.

ARROWROOT MADE FROM *Maranta arundinacea* AT BERMUDA.

	No. 1. %	No. 2. %
Moisture	13·50	15·86
Starch	82·84	82·61
Ash	0·124	0·172
Proteids	0·052	0·087
Fibre (by diff.) ...	3·484	1·271

ARROWROOT PREPARED FROM *Maranta arundinacea* (1 AND 2) AND *Canna edulis* (3 AND 4) IN QUEENSLAND.

	No. 1. %	No. 2. %	No. 3. %	No. 4. %
Moisture ...	15·010	14·28	17·360	16·36
Starch ...	76·220	78·80	81·520	82·00
Ash	0·308	0·38	0·142	0·38
Proteids ...	0·152	0·98	0·078	0·07
Fibre (by diff.)	8·310	5·56	0·900	1·19

The analyses given show that the idea so generally held of the nourishing qualities of arrowroot is a delusion. Starch, present to so arge an extent, is simply a heat and fat producer, and possesses no muscle-building power. he proteids, which are true muscle builders, re present in extremely small amount. Arrowoot may, however, when mixed with milk, eggs, lavourings, &c., be made into delicate, nourishng dishes which will tempt a failing appetite, nd thus serve the purpose for which it is so argely used in the dietary of the invalid.

[H. W.]

Arsenate of Lead. See ARSENIC COMOUNDS.

Arsenic.—The connection of this element with agriculture arises mainly from the fact that some of its compounds are of an exceedingly poisonous nature, and hence are extensively used as the active constituent of many substances employed as insecticides and fungicides.

Arsenic occurs in small quantities in combination with other elements widely distributed in nature. In combination with metals it forms the important group of ores called arsenides, and with a metal and sulphur as arsenical pyrites. The element has a steely-grey metallic appearance; it sublimes without fusion at the ordinary pressure, and at a temperature above 100° C. The vapour is yellow and emits a smell of garlic. The element is probably not poisonous, but in contact with air and animal fluids it readily forms compounds of a poisonous and toxic nature. Arsenic combines with oxygen to form two oxides, namely, arsenic trioxide and pentoxide, the former being the more poisonous. Arsenic trioxide, As_2O_3, arsenious acid, is sold as white arsenic, flowers of arsenic, or simply as arsenic. It is only very slightly soluble in water. Either as the oxide or when combined with soda or potash, it is used for killing insects and destroying fungi. See Insecticides and Fungicides.

It is a powerful poison. The best antidote for arsenic poisoning is the immediate use of ferric hydrate or magnesium oxide. However, should the arsenic have already been absorbed into the system, these will be of little avail. The smallest dose known to have proved fatal to human beings is 2½ grains, to cattle between 5 and 6 gr., and to a dog ¼ gr. As much as 20 gr. per day are known to have been given to a horse, so that the poisonous dose for this animal appears to be very large. The effect of small doses on a horse is to improve the coat and general appearance of the animal, which fact is, unfortunately, known among many grooms and farriers.

Arsenic used in minute doses is a powerful febrifuge; when used habitually, comparatively large quantities may be taken. It is employed in some pharmaceutical preparations, and in veterinary arsenical medicines for skin diseases and other ailments.

In combination with sulphur, arsenic forms the two compounds known as realgar or orpin rouge, and orpiment or king's yellow. Arsenic compounds are used extensively in the arts—in decreasing amounts as a flux for glass; in the preparation of pigments, some of the common ones being king's yellow, Scheele's green, Schweinfurt green; as a constituent of arsenical soaps, &c.

Plants die when placed in a solution of arsenic, though steeping corn in such a solution previous to planting, for preventing smut, &c., seems not to injure the growth of the future plant. When mixed with earth it has been found that plants will grow on such earth, and that they only assimilate infinitesimal amounts of the arsenic. It is occasionally found in sulphuric acid or oil of vitriol, when arsenical pyrites have been used in the manufacture of the acid. By the use of such acid it may sometimes get into superphosphate of lime, sugar, beer, &c. See following articles. [R. A. B.]

Arsenical Dips. See Arsenic Compounds below, Sheep Dips.

Arsenical Washes.—Arsenical washes are used as insecticides for biting-mouthed or mandibulate insects attacking fruit and other trees, and also as poisons made into meal for other insects, such as Locusts and surface larvæ. Three kinds of these washes are used, namely, arsenate of lead, Paris green, and London purple. All three are poisons, and must not be used on ripe or ripening fruit. They may be employed up to six weeks before the fruit is picked. All three should be sprayed over the trees in a fine mist. There is no fear of stock being poisoned on grass orchards where these are used. As with all other insecticides it is very important that these washes should be used when the caterpillars are small, and not when they are mature and the damage done.

(*a*) Arsenate of lead is prepared as follows:—

Acetate of lead (98 per cent strength) ...	7 ozs.
Arsenate of soda (pure)	3½ ozs.
Water (soft)	10 gal.
Treacle	1 lb.

Dissolve the first two and add to the water, and then stir in the treacle.

If 'dry' arsenate of soda is used; 2 ozs. only are necessary.

It has four advantages over the following, namely: (1) less burning effect on foliage; (2) greater killing power; (3) more adhesive; and (4) does not require so much agitation. It can be mixed with the fungicide Bordeaux mixture. It may also be obtained in a ready-mixed paste form known as Swift's Arsenate of Lead Paste.

(*b*) Paris green may be obtained either as a powder or as paste (Blundell's). It is used at the rate of 1 oz. to 10 gal. of water. It is improved by the addition of 1 oz. of lime. It has a tendency to burn the edges of the leaves and must be kept constantly stirred, as it settles rather rapidly in water.

(*c*) London purple may also be used for similar purposes, but is not so usually employed as the two former. [F. V. T.]

Arsenic Compounds.—The compounds of arsenic are used in agriculture almost entirely as insecticides, that is, as poisons to destroy insects; in fact, the chief industrial use of the compounds of arsenic is in the preparation of insecticides, including sheep dips, and far more arsenic is used for this purpose than for all other purposes put together. They are also used, but to a much smaller extent, as drugs for animals, and as weed-killers. Their main uses depend upon their strongly poisonous nature. They poison insects and their larvæ as well as higher animals. When applied in a soluble form to either the roots or foliage of plants, they injure the plants. Hence, for application to the foliage of plants in order to kill injurious insects insoluble compounds of arsenic are used. On the other hand, when arsenical smears or washes are applied to animals to destroy parasitic insects, soluble compounds of arsenic are generally used. So also, when used as weed-killers, soluble compounds are used.

The chief compounds of arsenic used for killing insects are white arsenic or arsenious acid and its salts the arsenites, and salts of arsenic acid, which are called arsenates. White arsenic itself is slightly soluble in water, and cannot be used for application to the foliage of plants, as it 'burns' or 'scorches' the leaves. In other words, it poisons the leaves, as well as any injurious insects feeding on the leaves. Its compound with soda, sodium arsenite, is even more soluble. Both of these substances are used for making sheep dips and dressings to destroy the insect pests of animals. When white arsenic is boiled along with carbonate of soda, which is also known as soda ash, soda crystals, and washing soda, it forms arsenite of soda, and such a preparation forms an important constituent of many sheep dips. The class of dips known as poisonous dips consist of arsenite of soda, with or without white arsenic, mixed with other substances such as sulphur and soap, and sometimes also with carbolic acid and other tar acids. Arsenic and sulphur dips are among the most generally used and effective of sheep dips. (See SHEEP DIPS.) The chief arsenic compounds used as insecticides for application to plants are arsenites of copper and lime, aceto-arsenite of copper, and arsenate of lead. These are all insoluble compounds, which, when pure, do little or no damage to the foliage of the plants on which they are sprayed. Insecticides are of two kinds: (1) those which are consumed by insects with their food, and act as internal poisons; and (2) those which act upon insects from the outside, and cause death by closing up their breathing apparatus, or by burning or irritating their skin, or in some other external manner. The arsenic compounds mentioned are the insecticides by far the most extensively used as internal poisons. See INSECTICIDES.

Paris green, or aceto-arsenite of copper, is the most important member of this group. It is a compound of two copper salts, copper metarsenite and copper acetate, of the formula $3\,Cu(AsO_2)_2 \,.\, Cu(C_2H_3O_2)_2$. It forms a brilliant-green heavy powder, and was at one time extensively used as a pigment. It is also known by a number of other names such as emerald green, Schweinfurt green, and imperial green. It was first introduced as a remedy for a caterpillar which was doing great injury to the cotton crop in America about 1870, and soon after thoroughly established its reputation by the success with which it was used against the Colorado Beetle. Since then it has been applied to a great variety of plants in combating a great variety of insect pests, and has had a great effect in educating fruit-growers, hop-growers, and others engaged in the cultivation of valuable crops, in the use of poisonous sprays to destroy their insect enemies.

Pure Paris green should contain as follows:—

Copper oxide (CuO)	30·7	per cent.
Arsenious anhydride (As_4O_6) ...	57·8	,,
Acetic anhydride ($C_2H_3O_2$) ...	11·5	,,

It should contain no free arsenious anhydride, and should be quite insoluble in water. Commercial samples generally contain a slightly higher percentage of arsenic than shown above. They sometimes contain some free white arsenic or other soluble arsenic compound. Such samples should be avoided, as they are apt to damage the foliage of plants. Paris green is used both wet and dry. When applied wet it is used at about the rate of 1 lb. to 100 to 200 gallons of water. For tender plants even weaker preparations are used. It is common to mix about an equal weight of quicklime with the Paris green. This renders insoluble any soluble arsenic which might be present. As Paris green is a heavy powder and readily sinks, the mixture should be kept stirred all the time the spray is being applied. It should be purchased in as fine a powder as possible.

When applied in the dry state Paris green is largely diluted with some neutral substance, such as flour, and dusted on the foliage preferably when it is wet with dew. From 20 to 50 parts of flour are usually taken to 1 part of Paris green. Sometimes slaked lime is used also. Care should be taken that the worker does not inhale the poisonous powder.

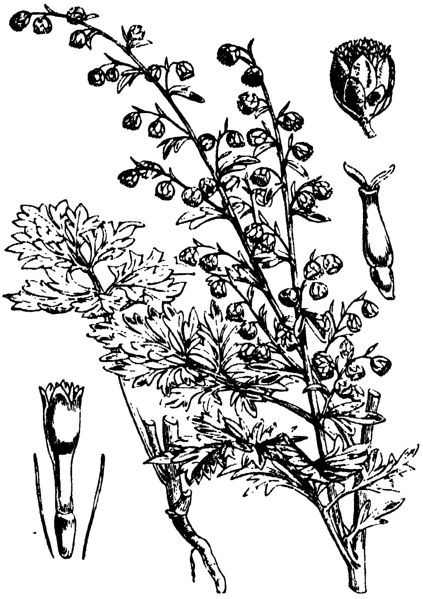
London purple is a by-product obtained in the manufacture of certain aniline dyes. It is composed mainly of arsenite of lime. It is cheaper than Paris green, but is more apt to injure the foliage. As a rule, Paris green is to be preferred. Other preparations which are of a similar nature, and also contain arsenite of lime, are known by such names as Paris and English purple. Sometimes also arsenite of lime is made by boiling together quicklime and white arsenic, in the proportion of 2 lb. quicklime to 1 lb. arsenic. Scheele's green, copper hydrogen arsenite, $CuHAsO_3$, is also used to a small extent.

Arsenate of lead is practically the only arsenate which is used as an insecticide. It is prepared by dissolving in water and mixing arsenate of soda and acetate of lead. Three parts of arsenate of soda are used to 7 parts of acetate of lead. The fine white precipitate of arsenate of lead which is formed remains in suspension in water much more readily than Paris green. It is much diluted for application, and frequently some treacle or syrup is added in order to make it adhere well to the leaves. Arsenate of lead is quite insoluble, and, when properly prepared, does not injure the foliage even of tender plants.

Soluble arsenites and arsenates readily poison plants as well as animals. As mentioned already, they scorch the foliage of plants when sprayed upon it, even in very dilute solution. So also when applied to the roots of plants they kill them. They are therefore sometimes used in the manufacture of weed-killers.

As poisonous sheep dips contain soluble arsenic compounds, what is left over after sheep are dipped should not be permitted to escape into watercourses, where it would poison fish and might poison cattle which drank the water farther down the stream. Neither should the remains of arsenical sheep dips be allowed to drain away to hedges and trees, or any valuable plants, or they may poison them. [J. H.]

Artemisia (Wormwood). — Artemisia is a genus of plants having a strong odour and a bitter taste, belonging to the natural order Compositæ, and to the same tribe as the common Groundsel and Ragweed. The common name Wormwood refers to the medicinal use of the plant. Most of the species are adapted for life in dry arid regions; their leaves are much divided and grey with hoary hair. We find large arid tracts of the United States, and of Mexico, bearing species of wormwood so thick and interlaced that they are impenetrable to man or horse. In the Steppes of Tartary the same thing occurs on a most extensive scale. Common Wormwood or Absinthe (*Artemisia Absinthium*) is a native of our sandy shores, and is also cultivated in gardens. This perennial herb has its leaves whitened all over with silvery hairs, and contains much of those bitter and volatile principles which, when incorporated with alcoholic spirit, make the vile beverage called absinthe. Mugwort (*Artemisia vulgaris*) is a common weed on roadsides and waste, sandy land all over Britain. Unlike common wormwood, its leaves are bald and green on the upper surface. It contains the same active principles as the other species, and was formerly employed for imparting flavour to spirituous beverages. The shrub Southernwood or Old Man (*Artemisia Abrotanum*) is a native of southern Europe, often cultivated in gardens for its fragrant aroma. Wormseed is sold by herbalists, and is composed of the flowerheads of various species of wormwood imported from the Levant. Various species of wormwood grow wild in Switzerland, and are used for imparting characteristic flavours to dairy produce.



Common Wormwood or Absinthe (*Artemisia Absinthium*)

Tarragon (*Artemisia Dracunculus*).—This species has bright-green undivided leaves and no bitter taste. It is cultivated in gardens, and the leaves and young shoots are used as ingredients in pickles, and sometimes infused in vinegar to make sauce for fish. [A. N. M‘A.]

Arterial Drainage.—By the system of arterial drainage the superfluous water of the land is carried away to the rivers, and by the rivers conveyed into the sea. From thence it returns to the land through vapour. Without a system of arterial drainage no large scheme of agricultural drainage can be effected. This is evident if we consider that a point of discharge for the full amount of water must be obtained somewhere, and it is equally possible to conceive that such may be impossible upon many estates. Some have, of course, streams, rivulets, or rivers, passing through, and some have access, by right or consent, to a watercourse which will serve the purpose. Many, however, possess no such power of reaching a duct sufficient to relieve them of the drainage water.

A landowner may not pass his drainage water on to, or through, his neighbour's land. He may, if the boundary ditch be his, drain into it and allow the water to squander itself where it will; but if the ditch be not his he possesses no such right. Hence the bar which faced landowners in the early days of drainage.

For many centuries drainage has been considered essential to agricultural progress, but little was done in the draining of land, beyond individual effort, until the latter part of the 18th century. Then, through the enterprise of some active and far-seeing spirits, the necessity for extensive operations dawned upon the agricultural world. Systems were tried, and much discussion followed. Some were adopted with reasonable success, some failed; but presently a bill was passed through Parliament authorizing the borrowing and expenditure of public money for the improvement of agricultural land by drainage. The work went on by leaps and bounds, much public money was spent, and a large area was drained, and the benefit resulting is known.

At first the mere passage of superfluous water from the land was considered sufficient, but it was soon discovered that many unforeseen benefits followed. It was found that drainage improved all land, whether wet or dry, by separating the particles of the soil, and by the admission of warm air. Harvests were earlier, the health of the districts improved, and even the climate and general atmospheric conditions became changed. It was found, too, that land could not be overdrained, except upon the score of economy.

Since the commencement of scientific drainage there has been no cessation, and the present satisfactory condition of agriculture is chiefly due to the fact that the arterial system is complete, or may be rendered so. The barrier set up by unwilling neighbours has been swept away by Act of Parliament, and the provisions of this Act will be presently considered.

There should be borne in mind, in dealing with the subject of arterial drainage, that artificial watercourses, and not pipe drains, are the matter in consideration. A drain, though a watercourse in fact, is essentially different, both in law and practice, from an artificial stream —the one is the feeder of the other; and the watercourse—like a trunk railway—delivers the supply. Rivers and rivulets are the natural arteries, and if approachable by every landowner the drainage of agricultural land would be simple; but this is not the case, therefore artificial watercourses became necessary.

The system may be considered as twofold—(1) for direct discharge of superfluous drainage water, and (2) for the carrying out of drainage improvements upon low-lying, water-logged lands abutting upon rivers, and upon estuarine levels.

To overcome opposition and to enable every landowner to procure an outlet, an Act was passed in 1861 entitled 'An Act to amend the Law relating to the Drainage of Land for Agricultural Purposes', 24 & 25 Vic. c. 133. This Act is comprehensive, and gives powers to every landowner with regard to outlets. It not only removes obstacles, but confers upon Commissioners of Sewers and Draining Boards the power of developing, extending, and creating works of drainage. In consequence thereof large areas of bog, moor, and low-lying levels have been rendered fruitful and profitable under cultivation.

The necessity for such legislation consisted in the fact that under the conditions implied by the Act individual effort would have been abortive, because no outlet for a large volume of water could be obtained. Part III of the Act, which gives powers to private owners to procure outfalls, is that which confers the greatest benefits upon the majority of landowners, and which chiefly influences ordinary agricultural drainage.

It is worth while to deal with this a little in detail. Section 72 authorizes any person interested in land to make application to an adjoining owner for leave to make drains or to improve existing drains through the lands of such owner.

Section 73 sets forth the mode of making such application. It shall be in writing under the hand of the applicant, and shall be served on the owner and on the occupier. The notice shall state the nature of such drain or improvements in drains, and be accompanied by a map, on which the length, width, and depth shall be delineated, and shall state the compensation which the applicant proposes to pay.

Section 74 deals with the assent to such application and to the compensation required. Such assent shall be by deed under his hand and seal.

Section 76 deals with dissent of adjoining owner. He shall be deemed to have dissented from the application made to him if he fail to express his assent within one month after the service of the notice of application on him. In the event of such dissent, two or more Justices in Petty Session shall decide the following questions: (1) Whether the proposed drains or improvements in drains will cause an injury to the adjoining owner or to the occupier; and (2) whether any injury that may be caused is, or is not, of a nature to admit of compensation in money.

The result of such decision shall be as follows, that is to say (1) if no injury will be caused to the adjoining owner or occupier the applicant may proceed to make the proposed drains or improvement in drains; (2) if the decision be that injury will be caused, but that the injury is of a nature to admit of compensation in money, the Justices shall proceed to assess such compensation, and on the payment of it the applicant may proceed; (3) if injury will be caused which will not admit of compensation in money the applicant shall not be entitled to proceed.

Further sections confer upon the owner the right of entry upon the lands of the adjoining owner to clear and scour such drains as may have been opened, and confer the right of diversion upon the adjoining owner, provided drains equally efficient are made.

It is not necessary to deal more in detail with this important Act. By it the power of obtaining an outfall is secured, unless by such an irreparable injury will be done, but this is hardly likely to occur in well-considered schemes of great importance.

Arterial drainage usually involves works of considerable magnitude, which, to be efficient, should be undertaken by an engineer whose attention has been directed to hydraulic phenomena; but in cases where the simple alteration of a watercourse will meet the case, a draining surveyor may be able to include such alteration in his common duties of field drainage.

It is, of course, quite impossible to lay down any fixed rule in regard to depth and width, and 'fall', of such artificial watercourse. Such must depend upon the volume of water to be carried away, the descent, and consequent velocity. Obstructions in the form of bends and the like will have to be calculated. The depth and width will follow naturally the result of such complicated calculations. See also art. DRAINAGE. [C. E. C.]

Artesian Wells, so called from the French province of Artois, where they appear to have been first used on an extensive scale, are perpendicular borings into the ground through which water rises to the surface of the soil, producing a constant flow or stream, the ultimate sources of supply being higher than the mouth of the boring, and the water being thus forced out by hydrostatic pressure. The conditions of the possibility of an artesian well are a water-bearing stratum which forms a basin-like depression, impervious strata underlying and overlying it, and a plentiful rainfall at its outcrop. It may happen also that a succession of pervious and impervious rocks will yield water from bores sunk to different depths. The rocks most likely to yield water are loose and coarse jointed sandstones, limestones, and chalk.

If a boring is made to strata of this nature the water will flow out at the surface and constitute a true artesian well, provided always that the outcrop of water-bearing strata is higher than the level of the well. The principal water-bearing formations in this country are the Permian, Bunter, Middle Lias, Coralline Oolite, Portland and Purbeck beds, Hastings Sands, Lower and Upper Greensands, and Chalk.

The Thames valley at London is an area of which the geological structure is typical of that essential to success in the sinking of artesian wells. From the London Clay a boring might be made to pass successively through the following strata: Woolwich beds, Chalk, Upper Greensand, Gault, Lower Greensand, Weald Clay, Hastings Sand, and on to the Palæozoic ridge beneath. The Lower Greensand beds are very permeable, and they are enclosed between two layers of impermeable clay—the Gault and the Weald. The consequence is that when at Chatham or Rochester borings are carried down through the Chalk and Gault into the Greensand, water flows freely from the tube. At a less depth borings into the Chalk will yield the water which it derives from the hills of Hertfordshire and Essex to the north, and from the North Downs to the south of the valley.

Artesian wells are now common in many countries, and have been sunk to a depth of over a mile. As the water from such depths has a considerably higher temperature than that at the surface, artesian wells have been made to supply warm water for heating manufactories, greenhouses, hospitals, fishponds, &c. Although the theory is sufficiently simple, the actual construction of an artesian well may be attended with many difficulties and heavy expenditure. It is obvious also that, as the supply of water is necessarily limited, a quantity which might be sufficient for one well may become inadequate and gradually fail, if the existence in the neighbourhood of public works results in the construction of several bores. In general, however, the supply is sufficiently copious for domestic uses, and is sometimes so abundant as to be available for irrigation, to which purpose such wells have been made in the Sahara, Algeria, United States, and Australia. See AUSTRALIA, AGRICULTURE OF. [J. B.]

Arthritis (inflammation of a joint).—Several kinds of arthritis are recognized in animals: that arising from external violence, blows, strains, or wounds (traumatic); inflammation of joint structures of rheumatoid type; and a pyæmic joint-ill, so fatal among the new born or very young. If there is no puncture, and the tissues are not seriously injured, the inflammation may be expected to subside by treatment with warm poultices or cold affusions, saline or other aperients, and rest, with perhaps the support which a thick sheet of cotton wool with a bandage over it may afford. The worst forms of arthritis follow on punctured wounds (see OPEN JOINTS). The rheumatic form is due to 'some undefined noxious principle in the blood' (Axe), and in young animals is acute, and in old ones more frequently chronic. Early recognition, an aloetic purge, and a course of iodide of potassium will often cut short an attack, and apparently effect a permanent cure. Pyæmic arthritis is an infective disease due to a septic organism which enters the victim through a wound or abrasion, the most frequent gate being the open navel string, before it has undergone the natural drying process. This port of entry may be closed by dressing the umbilical cord with carbolic acid or other antiseptic substances. [H. L.]

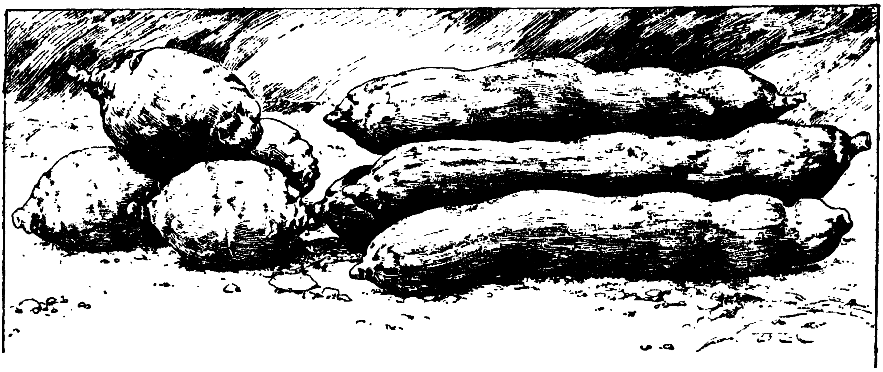
Artichoke (*Cynara Scolymus*, L.; *C. Cardunculus* var. *sativa*, Mor.).—The Artichoke, or Globe Artichoke as it is sometimes called, to distinguish it from the Jerusalem Artichoke (see below), is a perennial plant belonging to the nat. ord. Compositæ and resembling a very large thistle. It has not been met with in a wild state, and is supposed to be derived from the Cardoon (*C. Cardunculus*, L.), a plant which is indigenous in the Mediterranean region and in the Madeira and Canary Islands. The leaves, greenish-grey in colour, are divided in a pinnatifid manner, and from 2 to 4 ft. long, with somewhat spiny margins.

Artichoke—Perpetual

The flowering stems grow from 4 to 5 ft. high, and terminate in large globular or conical flower heads, 3 to 6 in. in diameter, the florets of which are tubular, and usually purple in colour, although white varieties are known. They flower during August and September, but the young flower heads are produced from July into late autumn. The scale-like bracts of the involucre, which latter forms the outer covering to the flower head, are green or purplish-green, and succulent. The thickened bases of these, together with the broad fleshy receptacle or swollen apex of the flowering stem within the head, are generally boiled and eaten with melted butter before the flower head is expanded. Sliced portions of the receptacle are sometimes eaten as a salad with oil and vinegar. [J. P.]

The artichoke is easily cultivated, preferring a deep, well-manured soil, and is propagated either from seeds or suckers. The seeds are sown in March in a little warmth, as in the case of celery, and as soon as they are large enough to be handled the seedlings are planted singly in 4-in. pots, and kept in a frame until May, when they are planted 18 in. apart in rows 1 yd. apart. In the warmer parts of the country the seeds may be sown in April in shallow drills 1 yd. apart, and the seedlings thinned to 18 in. apart in the rows, where they will produce good plants by August. Suckers, which are freely produced by old plants, are removed in April and planted in groups of three, 2 ft. from each other, in rows 4 ft. apart. They grow very freely, and the strongest of the suckers will in the autumn develop flower heads fit for use. If the heads are required for pickling they should be gathered when about 2 in. in diameter. The flower stems must be removed in November and the ground forked over, afterwards covering it with a good layer of stable manure. In very cold weather, litter or bracken may be sprinkled over the plants to afford protection. The plantation of artichokes should be renewed every fourth or fifth year. The flower heads proper are exceedingly handsome, resembling huge purple thistles. Groups of the artichoke are therefore sometimes planted for effect in parks and very large gardens. The best sorts are: Globe, Purple, Gros Chamus, and Perpetual, the last named being largely grown in the south of France. [W. W.]

Artichoke, Jerusalem (*Helianthus tuberosus*, L.).—Strange to say, this plant is neither an artichoke nor does it come from Jerusalem. The name 'artichoke' was given to it by early writers, on account of the taste of its tubers resembling that of the true Globe Artichoke flower heads. The term 'Jerusalem' is merely a corruption of the Italian *girasole* (Latin *gyro* = to turn; *sole* = with the sun), a name given to the sunflower, which is supposed to have a habit of turning its flower heads towards the sun, and following the apparent movement of the latter from east to west.



Jerusalem Artichoke (*Helianthus tuberosus*). 1, Jerusalem White; 2, Veitch's Improved Long White.

The Jerusalem Artichoke was first introduced into this country, in the early part of the 17th century, from the north-eastern parts of North America, and has since then been grown chiefly as an esculent vegetable in gardens. On the Continent of Europe it is not only used for human food, but is cultivated as a farm crop, and utilized for the feeding of horses, cattle, sheep, and pigs. It possesses many qualities which recommend its more frequent cultivation in the British Islands as food for stock, especially on the poorer types of soil, and in waste corners of the farm where little else could be profitably grown.

The plant belongs to the nat. ord. Compositæ, and to the sunflower genus, and in many points closely resembles some kinds of sunflower. It is a perennial, and bears thick underground rhizomes or tubers, which vary considerably in form and size, being in certain sorts somewhat like an irregularly shaped roundish potato, in others much longer. These tubers bear several buds, and unlike the potato give off thin fibrous roots. The external colour of the tubers may be purple, yellow, or white. When placed in the ground the buds upon them grow, and produce coarse, hairy, erect stems, which come aboveground and ultimately reach a height of from 5 to 8 ft. or more. The lower leaves are generally opposite and cordate-lanceolate, the upper ones ovate and alternate.

In the hottest parts of southern Europe the plants generally flower, the heads resembling small yellow sunflowers about the size of marigolds, in which ripe seed is sparingly produced. In the more northern parts of France and Germany. and in the British Islands, the Jerusalem Artichoke rarely flowers except in very hot seasons, and then does not ripen seed.

The plant is not fastidious in its soil requirements, nor in its demands for light or shade. It grows well under trees, and flourishes on almost all classes of soil from dry sands to strong clays; on peat and on gravels it thrives also. The best results, however, are obtained on sandy loams with good drainage. On account of its want of seed formation it is propagated by planting tubers.

The land should be cleaned and trenched, and a good dressing of farmyard manure added in the autumn, with about 3 cwt. of superphosphate of lime on the lighter classes of soil, or 5 cwt. of basic slag on heavier land. Where the land is sandy or gravelly, an application of 3 cwt. of kainit is beneficial, especially where only a sparing amount of farmyard manure is put on. For good results, manure should be given every two or three years. In spring the tubers are planted usually in March, about 3 in. deep, in runs 2 ft. to 2 ft. 6 in. apart, and 20 in. asunder in the rows. In some places on the Continent planting is carried on in October and November, especially on ground which is fairly dry and well drained. Where the tubers are small it is best to plant two or three together, but one larger tuber, planted like a potato, gives the best returns; the stems from small tubers being generally thin and spindly, and the yield small. The weight of tubers needed to plant an acre is from 12 to 15 cwt.

It is necessary to keep down weeds by hoeing for a time after the young shoots are up; but later, when the stems and leaves are well developed, they shade the ground and stifle out undergrowth of all kinds. The tubers may be dug up in autumn and stored in the same manner as potatoes, or left in the ground during the winter and dug up when needed in spring, the latter being perhaps the better plan. Although the tubers may become frozen, they are not damaged in any way if they are allowed to thaw in the ground—a fact no doubt in some way connected with the cell sap and the nature of the stored food materials in it, which is referred to later. When once planted and properly established on a piece of ground, no replanting is needed for many years, as the small tubers which remain in the soil when the main crop is dug are sufficient to start the crop again. The fact that every small tuber or piece of tuber will grow makes it exceedingly difficult to eradicate the plant when once established. The crop should therefore only be grown on ground which would otherwise be wasted or unremunerative. It is difficult to state what is the average yield of a crop of Jerusalem Artichokes, as it varies so much with the treatment the crop receives, and the kind of soil on which it is grown, but generally speaking the yield is smaller than that of a crop of potatoes grown on similar ground. The tubers are excellent food for all kinds of stock, either raw or boiled. They contain about 80 per cent of water and about 2 per cent of albuminoids —about the same as in potatoes. Unlike the latter, the Jerusalem Artichoke stores up little or no starch, the chief carbohydrates in the tubers being grape sugar and a peculiar soluble compound termed *inulin*, which is allied to grape sugar and starch. The soluble carbohydrates amount to about 15 or 16 per cent.

The young leaves and stems are sometimes cut and fed in a green state to cows and sheep, which thrive well on them; but when this practice is followed the yield of tubers is diminished considerably. They contain 68 per cent of water, 3½ per cent of albuminoids, 17½ per cent of soluble carbohydrates, and about 5½ per cent of crude fibre. [J. P.]

Artificial Butter.—At the instigation of Napoleon III, Hippolyte Mège-Mouriès, who was in 1870 employed on the imperial farm at Vincennes, carried out a series of experiments with a view to providing a substitute for butter which should not only be cheaper but less liable to deterioration. His experiments were somewhat interrupted by the Franco-Prussian war, but in 1873 the manufacture of oleomargarine, as the product was termed, was undertaken on a large scale.

The original process is briefly this: animal fat (beef fat was originally used, though the patent granted does not specify this) is crushed, ground, or disintegrated to break up the cellular tissues, and slowly raised to a temperature of 103° F.; 2 litres of gastric juice are added to 100 kilogrammes of fat while being rendered, in order to dissolve the tissues. When all the fat is melted 1 per cent of common salt is stirred in to aid the separation of the organized tissues, and the stirring continued for some time, after which the rendered fat is allowed to stand until it attains perfect limpidity. The melted fat is drawn off and maintained at a temperature of about 86° to 98°, until the stearine crystallizes out. The mixture of stearine and oleomargarine may be separated either by means of a centrifugal machine or by pressure; the oleomargarine flows out as a liquid, which when cooled down solidifies to a fat having approximately the same consistency as butter fat.

To transform the oleomargarine into a more perfect butter, it is mixed with one-tenth of its weight of milk or cream at about 71°, and the mass is thoroughly agitated and rapidly cooled: it is then worked between rollers, which causes it to become homogeneous, and to acquire the consistency of natural butter. An addition of mammary tissue to the extent of one-fiftieth of the weight of the milk or cream, one-hundredth part of bicarbonate of soda, and some colouring matter may be mixed with the milk or cream before agitating.

The modern process of the manufacture of artificial butter, though following broadly the lines laid down by Mège-Mouriès, in many respects departs from his original specification. The most noticeable points of difference are: the abandonment of the use of gastric juice, the rendering of the fat at higher temperatures, the use of vegetable oils and fats, the more perfect admixture of the fats and the milk, and the ripening of the mixture of fat and milk to imitate the flavour of natural butter.

The processes used differ somewhat according to the raw materials used and the class of product desired; the oleo oil is prepared from the caul fat of freshly killed oxen, which is washed in tepid and then in cold water, and allowed to stand in a cold room till thoroughly solid; it is broken up into small pieces by machinery, and then raised to a temperature of 150° till the fat separates in a clear liquid form. It is next cooled slowly till the stearine has crystallized out, and the oleo oil separated in a hydraulic press; the exact temperature at which this takes place depends on whether vegetable oils are to be used or not.

Neutral lard is also used, which is made from selected leaf lard by a process similar to the above, except that often no stearine is extracted.

Cocoanut oil is now largely employed for the manufacture of artificial butter; for this purpose it is purified and freed from taste and smell by treatment with alcohol.

Cotton-seed, earthnut, and sesame oils are refined by agitating while hot with a quantity of caustic soda solution necessary to remove the fatty acids; after settling, the oil is filtered. The oils are sometimes cooled to a low temperature, and the 'stearine' which separates out removed by pressure; the stearine is used for the manufacture of artificial butter.

To convert the fats into artificial butter a mixture having the melting-point and consistency of butter fat is made of neutral lard and one or more of such oils as oleo, cocoanut, cotton-seed, earthnut, and sesame; it is then mixed with milk or separated milk by suitable machinery in such a way that the product resembles cream. The machines used for this purpose consist of pumps, to which the melted fat and the milk are simultaneously supplied in suitable proportions, and which force the mixture at high pressures through small openings; the effect of this is to break up the fat into small globules, and, the mixture being rapidly cooled, the fat remains in a condition similar to that in which butter fat exists in cream. An addition of buttermilk or of a 'starter' is made, and the artificial cream is ripened and churned in the same manner as butter.

For the preparation of the inferior kinds of artificial butter the raw materials are less carefully purified, and the mixture with milk is made by churning the fat and the milk together and rapidly cooling without the ripening process.

It is now thoroughly established that artificial butter is perfectly wholesome, and digested nearly if not quite as easily as genuine butter. It is, however, much used for adulterating butter—a procedure which yields considerable profit. To suppress this, some special acts of Parliament have been passed: under the Margarine Act, 1888, artificial butter can only be sold under the name of margarine, and all packages must be conspicuously labelled; all margarine exposed for sale must also be labelled, and the paper in which it is wrapped must bear the word Margarine. Under the Sale of Food and Drugs Act, 1899, no margarine may be sold which contains more than 10 per cent of butter. A recent act provides for the inspection of margarine factories, and prevents margarine being sold under fancy names.

In some countries it is obligatory to add a proportion of sesame oil to margarine, as this substance can be detected in very minute quantities, and the adulteration of butter with margarine thereby exposed. The adoption of this or some similar provision for earmarking margarine was recommended by a recent Departmental Committee, but has not been carried into effect. Margarine may not contain more than 16 per cent of water. See also articles Margarine, Margarine Acts, Sale of Food and Drugs Acts, Blended Butter. [H. D. R.]

Artificial Grasses.—This name is applied to all the grasses which are sown to produce hay and pasture. The name is sometimes extended so as to include not only grasses, but clovers and any other plants included in mixtures. The grasses used for hay and pasture production may be usefully grouped into three divisions by the breadth of the leaf.

Top grasses—leaf broadest.
Bottom or sole grasses—leaf of medium breadth.
Bristle-leaved grasses—leaf quite narrow and bristle-like.

The top grasses are the largest and most productive grasses, with the deepest roots. The best are:—

Tall Oat (non-bulbous)—for light land.
Meadow Fescue.
Tall Fescue.
Timothy }
Foxtail } —for heavy land.
Cocksfoot.
Italian Rye Grass—of short duration.

The bottom or sole grasses are of medium size, and have roots of less depth in the soil. The best are:—

Perennial Rye Grass—usually of short duration.
Annual Rye Grass—of one year's duration—for laying down Timothy meadows.
Crested Dogstail.

The bristle-leaved grasses are the smallest grasses and have the shallowest roots. They should be used only on thin light land. Those most commonly sown are:—

Hard Fescue.
Sheep's Fescue.

The clovers are:—

Red, also called Cow Grass.
Alsike—for heavy land.
White.
Trefoil—for light land.

Trefoil, though usually included among clovers, belongs in reality to the Medick genus, and its botanical name is *Medicago lupulina.*

Miscellaneous plants are:—

Compositæ—Chicory and Yarrow.
Rosaceæ—Burnet.

[A. N. M'A.]

Artificial Incubation. See Incubation.

Artificial Manures.—This term is used in a popular sense to cover all the concentrated manures which have come into use during the last century. Strictly, it should include all manures which have been produced or prepared by art instead of by nature, and therefore even farmyard manure and lime, in the preparation of which art is exercised, are artificial manures. In ordinary use, however, the term means 'light' manures like superphosphate, sulphate of ammonia, or muriate of potash, in contradistinction to the old traditional bulky manures like farmyard manure and lime, which are sometimes called natural manures. As the term is used in a rough general sense, and not in a strict scientific one, it is difficult to say exactly what manures are included under it. A real guano, for instance, is more truly a natural manure than even farmyard manure, yet it is always looked upon by farmers as an artificial manure. It is proposed, for purposes of convenience, to treat all the manures to which the term is commonly applied, that is all manures except farm dung, composts, and the lime manures, as artificial manures. Nearly all these substances have been introduced into use as fertilizers since the beginning of the 19th century. No doubt certain substances, like bones, guano, woollen refuse, and some other waste materials, were used to a certain extent before that time; but it was only with the development of modern chemistry and plant physiology that a definite theory of manuring was formed, and that the modern artificial-manure industry, and the use of artificial manures on a large scale, became possible.

Manures are applied in order to increase the fertility of the soil or its power of producing crops. A large number of different chemical elements are taken up by plants from the soil through their roots. The uses of manures are to keep up the store in the soil of necessary chemical substances which is constantly being diminished by the removal of crops and by drainage, and to improve the mechanical, chemical, and biological condition of the soil. See MANURES AND MANURING.

The value of artificial manures depends practically entirely upon three chemical elements—nitrogen, phosphorus, and potassium. Though there are a large number of other elements taken by plants from the soil, several of which, as sulphur, magnesium, and iron, are quite essential to the life of plants, for a variety of reasons we have not to consider the supply of these in dealing with artificial manures, nor do we place any value upon them in estimating the values of manures. Sulphur and magnesium, for instance, are present in certain important artificial manures in large quantity, but they are not treated as of any importance from a manurial point of view. Sulphate of ammonia contains a larger percentage of sulphur than of nitrogen, but it is upon the nitrogen that the value of the manure is entirely based, and the sulphur is looked upon only as an accidental substance with which the nitrogen happens to be in combination. Again, kainit contains a considerable percentage of magnesium as well as of potassium, but though magnesium is a necessary constituent of plants, its presence in kainit along with potash is looked upon as a disadvantage rather than otherwise. (See POTASH MANURES; KAINIT.)

In addition to the presence of the essential elements it is necessary that artificial manures should contain these elements in forms of combination suitable for the use of plants. There are many compounds of nitrogen which are not suitable for use as manure. Some are useless, others are poisonous. Sodium nitrate is a most valuable manure, but sodium cyanide, though it contains a larger percentage of nitrogen than sodium nitrate, is a poison. Similarly, many compounds of phosphorus are worthless or injurious, and only a limited number of phosphates are really valuable as manures. Again, the value of artificial manures depends largely on the 'availability' of their essential constituents. Manures are said to be of high availability when they act readily and rapidly on crops, or in other words when they are readily and rapidly taken up by the roots of plants. The availability of manures depends, first, on their solubility. A soluble manure is more available than an insoluble one. Second, it depends, in the case of manures not readily soluble in water, on their fineness of division. If finely divided they expose a larger surface to weathering and bacterial actions, which break them up and render them available to plants. Third, in the case of organic manures, which have to undergo decay and mineralization before they become available to plants, the availability depends on the readiness with which they undergo decay. Anything which retards decay lowers the availability.

Artificial manures are commonly classified, according as they contain one or other of the three important manurial elements, into Nitrogenous manures, Phosphatic manures, and Potassic manures. Many of the well-known artificial manures, however, contain more than one important constituent, and some of them contain all three.

NITROGENOUS MANURES.—These are subdivided into three important classes:

1. *Nitrates.*—Nitrate of soda, nitrate of potash, and nitrate of lime.

2. *Ammonia compounds.*—Sulphate of ammonia is practically the only one in use.

3. *Organic compounds of nitrogen.*—Dried blood, dried flesh, shoddy and other wool waste, hair, feathers, skin, and leather refuse.

Of a somewhat different nature is the artificially manufactured calcium cyanamide, which also falls into this class.

In addition to these, which are valued only for their nitrogen, there are a number of others which contain other constituents of value. These are guanos, which contain both phosphates and potash in addition to nitrogen; bone meal, bone dust, bone flour, dissolved bones, and fish manures, which, along with nitrogen, contain phosphates. See NITROGENOUS MANURES.

PHOSPHATIC MANURES.—These are divided into:

1. *Soluble phosphates.*—That is, manures which contain a large part of their phosphate in the

water-soluble form of mono-calcium phosphate. The chief of these are superphosphate and dissolved bones. Dissolved bones contain a little nitrogen in addition to the phosphate.

2. *Citric-soluble phosphates*, a large proportion of the phosphate of which is soluble in dilute citric acid. The chief of these is basic slag. Of lesser importance are precipitated phosphate and the so-called 'basic superphosphate'.

3. *Insoluble phosphates.*—Mineral phosphates, such as Algerian phosphate, Florida phosphate, Carolina phosphate, and Belgian phosphate, together with bone ash and bone black. The other bone manures, bone meal, bone dust, and bone flour, which contain a little nitrogen, are also included in this class.

Some of these manures are, however, soluble to a considerable extent in citric acid, and if finely ground may be as available as manures included under 2. Thus bone flour is, generally speaking, as valuable and available a phosphatic manure as basic slag. See PHOSPHATIC MANURES.

The phosphates of fish manures also fall under 3, but the phosphates of high-class guanos fall under all three classes, 1, 2, and 3, since they are partly soluble in water, partly citric-soluble, and partly insoluble.

POTASSIC MANURES.—These are all soluble in water. The principal are: kainit, muriate of potash, and sulphate of potash. With muriate of potash may be classed the largely used manures known as potash salts or potash-manure salts. These are really impure or low-grade muriates of potash, and have been somewhat unfortunately named. Along with sulphate of potash may be included sulphate of potash-magnesia. Nitrate of potash is a nitrogenous as well as a potassic manure. Certain guanos and fish manures also contain some potash, and in some parts of the world wood ashes, seaweed ashes or kelp, and other plant ashes are or have been used as potash manures. See POTASH MANURES.

HISTORY OF ARTIFICIAL MANURES.—The artificial-manure industry may be said to have originated in the second quarter of the 19th century, and has now reached enormous proportions. Before that period bones had been used to a limited extent, and their use as well as that of woollen waste and some other substances was probably known to the civilized ancients. Guano also was known as a manure to the comparatively civilized Peruvians, before the appearance of Europeans in South America. In the early years of the 19th century a considerable industry began to spring up in bones for use as manure, and attempts were made to improve the condition of the bones by boiling and chopping them. About 1825, steam engines were erected for grinding bones, and a finer bone meal than had been hitherto used was introduced. (A. Smetham, Jour. Socy. Chem. Ind. xvii, 980.)

It was about 1840, however, that the foundations of the great modern fertilizer industry were really laid, for about that date several of the most important branches of the industry began to be developed. It was about this period that a great revival of interest in the applications of chemistry to agriculture took place, due largely to the influence of the great German chemist von Liebig, and to the work of the great French agricultural chemist Boussingault. Extraordinary expectations were raised as to what chemistry was going to do for agriculture, and while general popular interest soon died down, and the practical man soon became impatient and disappointed when his extravagant hopes were not at once fulfilled, much solid result remained. Not the least valuable of the practical results was that a rational chemical theory of manuring was developed and experimentally tested, and a demand created for manures which was at the same time supplied by the discovery of a number of the most important artificial manures.

One of the most important of the artificial-manure industries is the manufacture of dissolved phosphates. To Liebig belongs the credit of first suggesting that phosphates might be made more active and valuable by rendering them soluble in water by treatment with sulphuric acid. This suggestion was taken up by Mr. Thomas Proctor, a glue and bone-manure manufacturer, who in 1837–8 experimented with manures made from bone black and acid, and in 1839 made dissolved bones. He started in this year the sale of a manure composed of dissolved bone and potash salt under the name of *German compost.* In 1840 Mr. Lawes, afterwards Sir John Lawes, whose famous agricultural experiments at Rothamsted are so well known, commenced to manufacture dissolved phosphate from bone ash, and soon after he appears to have made superphosphate by treating ground coprolites with acid. This laid the foundations of a great new industry, which has since developed to enormous proportions. At first the impure phosphatic nodules known as coprolites, which are found in various parts of England (see COPROLITES), were used, but with the growth of the industry other phosphates were imported from abroad, and now all our mineral phosphates are obtained from foreign deposits which yield material of higher quality than coprolites. In 1906, 442,970 tons of phosphatic rock were imported into the British Isles, chiefly from the United States and Algiers, and the world's consumption of phosphatic rock is measured by millions of tons per annum. The output of the beds of the United States alone is over 1½ million tons per annum. Nevertheless during the past few years the price of raw mineral phosphate has constantly been going up, because the production is unable to keep pace with the consumption. See PHOSPHATES and SUPERPHOSPHATES.

Another great manure industry which had its origin about 1840 was the guano industry. As has already been stated, the use of guano as manure appears to have been known to the natives of South America long before it was brought to Europe. The famous traveller von Humboldt studied it, and brought some to Europe in 1804. It was about 1839 that the import of Peruvian guano began on a commercial scale. It rapidly grew, and in the 'fifties, hundreds of thousands of tons were imported annually. This continued till about 1870, when the supplies in the great Peruvian deposits began to run short, and the production gradually diminished. The principal deposits are now completely worked out, and there is no guano left of the quality of the old Peruvian guano. The total import now is only a small fraction of what it was in the height of the industry, and is almost entirely composed of inferior guanos not comparable in quality with the older product. The interest of guano is now mainly historical.

No manure ever played so important a part in educating farmers to use concentrated manures as did guano. Even in these days of agricultural education, farmers do not accept new ideas quickly, and do not attend much to what is written for them or told to them by scientists. In the middle of last century it was still more difficult to reach the ear of agriculture. The farmers of that generation knew practically no manures but dung, lime, and, to a small extent, bones. To them Peruvian guano came as a revelation. No amount of teaching, experimenting, and writing on the properties and uses of artificial manures could ever have opened their eyes to the possibilities of such concentrated fertilizers as the mere introduction of guano did. There probably is no manure now on the market of equal merit as an all-round fertilizer to Chinchas guano. It would be almost impossible now to make a manure equally rich in available nitrogen, phosphates, and potash except at a prohibitive price. In the guano, too, the nitrogen and phosphates were in almost ideal forms of combination. Immediately available nitrate, nearly as quickly available ammonia compounds, and more slowly available organic nitrogen were all present in the same substance. The phosphates similarly were of various degrees of solubility and availability. Finally, the manure had a fine rich smell, which even yet so many farmers demand in a manure, and which is so much more satisfying to them than odourless substances like nitrate of soda or sulphate of ammonia. It was the ideal concentrated manure, and it came to a generation unaccustomed altogether to any concentrated manure, and knowing only slow-acting manures like dung and bones. It is no wonder that it produced an effect on the agricultural mind such as no other manure ever produced. The stories of it were at first hardly credited; then someone obtained a sample, and the results were talked about at markets and wherever farmers met, and soon everyone was trying it. So in a very few years the demand grew from nothing to hundreds of thousands of tons, and a new branch of commerce arose.

The nitrate-of-soda industry originated about 1830. At first, however, it grew slowly. The whole of our supplies are drawn from the same rainless district in South America as yielded the Peruvian guano, but, whereas the guano was derived from islands off the coast, nitrate is obtained from a plateau lying some distance inland. During the five years, 1840-4, the average export of nitrate from South America was 14,640 tons per annum. The amount continued to grow steadily till about 1870. Since then it has increased with great rapidity. The following table shows the exports from Chile from 1830 to 1906:—

1830	800 tons
1840	10,100 ,,
1850	22,800 ,,
1860	52,200 ,,
1870	136,287 ,,
1880	225,559 ,,
1890	1,050,119 ,,
1900	1,435,400 ,,
1906	1,707,475 ,,

The great expansion in the nitrate industry after the 'seventies was partly due to the running out of the supplies of guano, but this was not the main cause. It is important to note that the British consumption of nitrate has practically stood still since 1870, and the increased consumption is entirely due to the demand from other countries. Up to the later 'seventies the United Kingdom was the great market for nitrate as for all other artificial manures; since then, though the British consumption has not decreased, it has gradually receded into a quite secondary position. Germany and the United States are now the greatest consumers of nitrate, and even so small a country as Belgium is a larger consumer than the United Kingdom. During the past generation foreign countries have learned to use artificial manures on a large scale. Though it was later before a knowledge of the use of such manures became general among them, their excellent systems of agricultural education and research soon spread the necessary information, and the practical value of their system is well illustrated in the rapidity with which the use of nitrate of soda and other fertilizers spread in these countries. Another cause which led to the greatly increased use of artificial manures, and in particular of nitrate of soda, was the development of the sugar-beet industry, which has now reached such great proportions in Germany and other Continental countries. Great quantities of nitrogenous manure, and in particular of nitrate, are used in the cultivation of this crop.

The great rival to nitrate of soda is sulphate of ammonia. The use of ammonium salts as fertilizers began about the same time as that of nitrate of soda. At first both the chloride and the sulphate were used, but the cheaper sulphate soon established its supremacy.

Sulphate of ammonia is produced as a by-product by industries which destructively distil coal or shale. It was at first obtained from the ammoniacal liquor of gas works, but later, iron works, shale works, coke-oven works, and producer-gas and carbonizing works all became producers of this valuable fertilizer. As in the case of nitrate of soda, the production of sulphate of ammonia has increased with great rapidity during the past thirty years. Previous to that time the United Kingdom was the great producer and consumer. Now though the United Kingdom remains the greatest producer, Germany is not far behind, and is a much larger consumer. By far the larger part of the sulphate of ammonia produced in the United Kingdom is now exported principally for agricultural use abroad.

The following table shows the increase in the production of sulphate of ammonia in the United Kingdom since 1872:—

1872	42,000 tons
1882	72,000 ,,
1892	157,000 ,,
1902	220,000 ,,
1906	289,000 ,,

In 1906 the production in the United Kingdom was made up as follows:—

	Tons.
Gas works	157,160
Iron works	21,284
Shale works	48,534
Coke-oven works	43,677
Producer-gas and carbonizing works ...	18,736
Total ...	289,391

It is estimated that the whole world's production in 1906 was a little over 700,000 tons. In the United Kingdom the estimated consumption for all purposes has during recent years averaged about 70,000 tons per annum. Though the chief use both of nitrate of soda and of sulphate of ammonia is for agricultural purposes, this is by no means the only use. Very large quantities of nitrate of soda are used in the manufacture of explosives and for other chemical industries. During the South African War the British consumption of nitrate increased considerably on account of the increased demand for the manufacture of explosives. There is a considerable demand for sulphate of ammonia also, for purposes other than use as manure.

Potash manures were comparatively little used till recent years, and even yet are not used to the same extent as nitrogenous and phosphatic manures. In the early days of the use of artificial manures the relative importance of the different classes of materials was not clearly recognized. It was at first supposed that it was necessary to return to the soil all the constituents of the ash of plants, and therefore soda and magnesia as well as potash were included in complete manures. It was only gradually recognized that potash holds a position of importance quite different from that of soda or magnesia, and has to be given a place only second to that occupied by nitrogen and phosphate. Again, the full recognition of the place of potash was delayed, and is even at the present to some extent obscured by the fact that on certain soils potash manures are little, if at all, required. Some soils naturally contain such stores of potash in forms sufficiently available to supply the needs of plants, that potash manures are practically without effect on them. These are generally heavy soils, soils which contain a considerable proportion of clay. On the other hand, most light soils are deficient in potash, and respond well to the action of potash manures. Even among heavy soils many contain their potash in such unavailable forms that dressings of potash manures are often beneficial.

Another reason why the use of potash manures did not become established in the early days of artificial manuring, as the use of nitrogenous and phosphatic manures did, was that no large source of supply of such manures was known. Nitrate of soda, sulphate of ammonia, bones, and mineral phosphates, could all be obtained in sufficient quantity to meet the requirements of the times, but the known sources of potash salts were very limited, and potash salts were so dear as to render their general use impracticable. Peruvian guano contained a little potash, but the amount was small in comparison with the nitrogen and phosphate in the guano. There were, indeed, some small supplies of nitrate of potash available. This substance is a most valuable manure, as it is both a nitrogenous and a potassic manure, but the supplies of it were very limited, and were nearly all wanted for the manufacture of explosives. In some places, wood ashes were used. These, however, do not contain a large percentage of potash, and the supply of them in the British Isles, at any rate, is so small as to be negligible. The ash of seaweeds, known as kelp, was also used to supply potash salts, and a small amount of potash manure is derived from this source up to the present day. The potash manures derived from kelp were too limited in quantity and too expensive to come into general use. It was not, therefore, till the great natural supplies of potash salts in the mines at Stassfurt-Leopoldshall, in Germany, were discovered, that it was possible for potash manuring to become general.

These mines have been worked for common salt since about 1840, but it was not till after 1860 that the value of the potash salt, which is found overlying the main deposit of rock salt, was recognized. Great salt deposits are found at various depths, underlying a large portion of the central European plain. These deposits have been formed, like our own deposits in Cheshire, from sea water. But it is only in a limited district in the neighbourhood of Stassfurt, in Prussia, and the closely adjoining Leopoldshall, in the duchy of Anhalt, that deposits of potash salts mixed with salts of magnesia, soda, and lime are found overlying the rock salt. (See POTASH MANURES.) These deposits were first worked for potash about 1862, and since then the industry has constantly grown. In recent years the growth has been very rapid.

Two kinds of manure are turned out by the potash mines, crude unmanufactured salts like kainit, and concentrated manufactured salts like muriate of potash. The consumption of both of these is rapidly increasing.

The following table shows the world's consumption of kainit and muriate of potash:—

	Kainit.	Muriate of Potash.
1870	20,301 tons	— tons
1880	139,491 ,,	96,832 ,,
1890	401,871 ,,	134,760 ,,
1900	1,189,394 ,,	206,471 ,,
1906	2,639,732 ,,	259,163 ,,

Potash salts are used to a large extent for other than agricultural purposes. It is estimated that for agricultural purposes and for other industrial purposes the total world's consumption of potash in all the various potash salts may be given as follows:—

	Agricultural purposes.	Industrial purposes.
1880	29,127 tons	39,453 tons
1890	71,679 ,,	50,623 ,,
1900	255,722 ,,	70,257 ,,
1906	452,804 ,,	77,166 ,,

It will be noticed how very much more rapidly the consumption of potash for agricultural purposes is increasing than its consumption for other purposes.

The latest of the great artificial manures to come into use is basic slag. This manure is also known as Thomas Slag, Thomas Phosphate Powder, Albert's Slag, Basic Cinder, and by other names. It is a by-product obtained in the manufacture of steel from phosphoretic ores by the basic or Thomas-Gilchrist process. At first it was a waste product, but it came into use as a manure when it was recognized that the phosphate which it contains is mainly a basic phosphate of lime, which is more soluble than the phosphate in bones and mineral phosphates. It is therefore only necessary to grind the slag finely in order to render the phosphate available to plants. See Basic Slag.

As the discovery of the basic process rendered it possible to use for steel manufacture great quantities of iron ore which had before been useless for that purpose, the manufacture of steel by the basic process has increased very rapidly, especially in Germany, and the amount of slag produced has also increased very rapidly. Though this manufacture was originally a British one, it is chiefly Germany which has been benefited by it. It was in Germany that the value of basic slag as a fertilizer was first recognized, and that country is now not only the chief producer, but also the chief consumer of basic slag.

Basic slag was first introduced as a manure about 1885. Its use has increased so rapidly that it is now, after superphosphate, the chief phosphatic manure. The following table shows the increase in the estimated production of basic slag in the whole world since 1885:—

1885	150,000 tons
1890	420,000 ,,
1895	850,000 ,,
1900	1,760,000 ,,
1906	2,383,000 ,,

In 1906, while the production of basic slag amounted to 2,383,000 tons, the consumption amounted to 2,412,000 tons. The following table shows the estimated amount of slag produced by various countries in 1906. (These figures have been supplied by The Chemical Works, late H. & E. Albert, London, E.C.)

Germany ...	1,510,000 tons
United Kingdom	300,000
France ...	235,000
Belgium ...	250,000
Austria Hungary	65,000
Russia ...	18,000
United States	5,000

It is estimated that, in 1906, 1,300,000 tons of slag were used in Germany, and 167,000 tons in the United Kingdom.

Basic slag differs very widely from superphosphate in its properties and use. While superphosphate is an acid manure and tends to neutralize and use up the available lime of the soil, basic slag is an alkaline manure and adds a little available lime to the soil. No doubt the presence of this lime adds to the value of basic slag. (See Basic Slag.) While it is customary to base the value of artificial manures on the nitrogen phosphate and potash which they contain, and to take note only of these constituents in estimating their values, it is to be remembered that other constituents have some value, at any rate in modifying or conditioning the action of the main constituent. Thus, to take another example, the presence of common salt and of magnesia compounds along with the potash salt in kainit considerably modifies the action and value of the potash in that manure as compared with sulphate or muriate of potash. See Potash Manures.

The substances of which some account has already been given, bones, guano, mineral phosphates, and the superphosphate derived from them, nitrate of soda, sulphate of ammonia, potash salts, and basic slag, are the artificial manures of primary importance. The others are obtained in much smaller quantities, and though many of them are of great importance, especially in certain districts, they are not of the same world-wide use and significance. As has been shown, the demand for artificial manures is constantly and rapidly increasing, and it is probable that other materials will in time come into extensive use. In the case of nitrogenous manures in particular, great efforts are at present being made to widen the sources of supply. New waste materials, such as by-products of various industries, are constantly being brought into use. Of these we have an example in fish manure or fish guano. Fish refuse has been used from time immemorial in the raw state as manure, especially in the neighbourhood of fishing villages. But in recent times the fishing industry, like other industries, has tended to become concentrated in a few comparatively large centres. In these, immense quantities of fish refuse are obtained, which it would be difficult or impossible to use in the crude state. It is these waste materials which are dried and ground into a valuable nitrogenous and phosphatic manure known as fish powder, fish manure, fish guano, &c. Large quantities of this are now produced, and it forms a valuable manure, but as the supplies of it, though large, are local and limited, it does not form a manure of the same primary importance as superphosphate or basic slag.

The great store of nitrogen in nature is in the atmosphere, where it exists in the free state chemically. All the nitrogen in combined form in the earth's crust must have been originally derived from the atmosphere, and the investigations of the natural processes by which free nitrogen has been brought into combined forms form one of the most interesting chapters in the history of agricultural science. In recent years several attempts have been made to use these natural agencies, chiefly bacteria, to bring nitrogen into combined forms in the soil, available for use by plants. In fact, attempts have been made to manure the soil with nitrogen through the help of bacteria. The consideration of this kind of manuring belongs to a different branch of the subject. (See INOCULATION OF SOILS.) But it is proper to mention here the attempts which are being made to form nitrogenous manures by causing the nitrogen of the air to combine with other substances. There are two such manures at present attracting attention. These are nitrate of lime, and calcium cyanamide, which is also known as lime nitrogen. Both of these are manufactured by employing electric power to bring the nitrogen into combination. A cheap supply of electricity is therefore a necessity of their successful manufacture. It is probable, therefore, that their production will take place where there is plenty of water power which can be turned to account to produce electric power. These substances appear to be comparable to nitrate of soda and sulphate of ammonia in manurial value, and as the machinery for their production is perfected they may become in the near future very important nitrogenous manures.

A great deal of the manure used by farmers is in the form of mixtures made up for special crops. These turnip manures, grain manures, potato manures, &c., are more or less valuable mixtures of nitrogenous, phosphatic, and potassic manures. They contain such substances as superphosphate, bone meal and bone flour, sulphate of ammonia, fish manure, dried blood, flesh manures, and other waste substances, with or without potash salts. These are mixed together in proportions which the manufacturer thinks will be likely to suit the requirements of the crop to which the manure is to be applied. These manures therefore are merely convenient forms in which the simple manures already dealt with are retailed to the farmer. Generally speaking, the farmer who understands something of the properties and uses of artificial manures can manure his crops more economically and better by purchasing the simple manures and mixing them to the requirements of the particular crop and soil to which he intended to apply them.

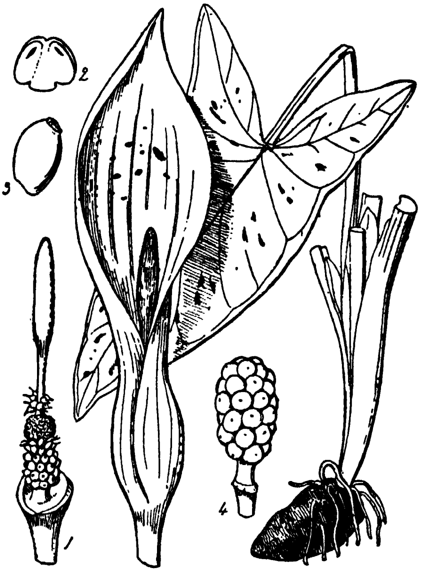
The great expansion which has taken place in the artificial-manure consumption of the world during the past thirty years has been referred to more than once already. Till recently western Europe was the only market for artificial manures, and in western Europe the United Kingdom was the greatest consumer. A great change is now taking place. The chief countries of western Europe have already overtaken Britain as consumers of manures, and Germany now occupies the first place. But the United States have also become great consumers of fertilizers, and India, Japan, Australia, and other parts of the world are rapidly becoming important factors. The probability is that the demand in such countries as the United States will continue to grow at a rapid rate. In proportion to the area of cultivated land, the amount of artificial manure used in the States is still very small. Similarly in many other parts of the world the industry is as yet only in its infancy. Therefore either the output of all the chief manures will have to be greatly increased or prices will rise. It is obvious that the production of certain important manures cannot be increased indefinitely. The total supply of bones and of fish manure, and even of slag, which can be put upon the market in any year is limited by the number of animals killed, of fish caught, or by the amount of basic steel manufactured, and cannot be increased to meet an increasing demand. On the other hand, the supplies of mineral phosphates or of potash salts can be increased by opening new mines or increasing the output of old ones. But even with these the demand may increase so rapidly that the supply may not be able, for a time at any rate, to keep pace with it. The price then goes up. This has recently been the case with mineral phosphates.

In the British Isles the consumption of artificial manures, except in the case of potash salts, has not been increasing to any great extent during the past generation. Certain other countries, such as Germany and Belgium, now use considerably more manure per acre of cultivated land. The total artificial manure of all kinds used in the United Kingdom does not amount to more than ½ cwt. per acre of cultivated land per annum. Probably this could be increased to a considerable extent with advantage. Probably also, with increasing knowledge of the properties and use of artificial manures, considerably greater advantage will be obtained from what is used. Much artificial manure at present is not used to the greatest advantage, and some of it is actually wasted through want of sufficient knowledge.

In considering the use of artificial manure in the United Kingdom the great consumption of imported feedingstuffs should not be forgotten. The importation of feedingstuffs is equivalent to the importation of manure. Each ton of linseed cake, for instance, contains a considerable amount of nitrogen, phosphate, and potash, and most of this should be recovered in the droppings of the animals to which it is fed. It is estimated that this country imports in the form of cattle foods three times as much nitrogen and many times as much potash as it imports in the form of manure. In cases where many cattle are fed and much purchased food is used, it should be possible to do with little or no artificial manure. Probably in such cases, where the dung is properly made, the only artificial manure required to keep the farm in good condition is some available phosphate. [J. H.]

See also articles under the specific names of each of the manures mentioned.

Arum maculatum (the Cuckoo Pint or Point, Lords and Ladies, Wake Robin) is a tuberous perennial plant, the typical representative of the Arum family of Monocotyledons. The tuber is a single roundish corm or short underground rhizome, which when ripe is filled with starchy matter, and from which rise up in April a few long-stalked dark-green arrowheaded leaves, which are sometimes green, but more usually spotted with black. These leaves surround a flower-bearing stem or scape, on the summit of which grows a long green sheath, or spathe, enclosing a spike of flowers with a fleshy axis, technically called spadix. The axis of the spadix consists of a slender club-shaped body, which becomes conspicuous when the spathe opens in the month of May; it has a dull surface, a soft fleshy texture, and is either yellow or purple. The flowers are of two kinds, male and female. All the female flowers are packed together at the base of the spadix, and immediately above them are the males, also packed together, the apical portion of the fleshy axis being quite bare and destitute of flowers. After flowering, the bare top of the spadix rots off, the spathe withers, and the female flowers grow into succulent red berries, which when ripe form a club-shaped mass, standing naked, the leaves themselves having by that time withered.



Cuckoo Pint or Wake Robin (*Arum maculatum*)

1, Spadix; 2, Stamen; 3, Female flower; 4, Fruit.

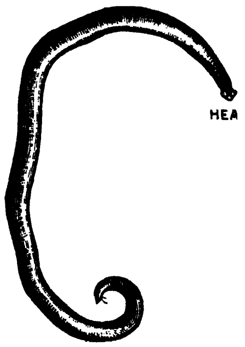
The corms of this plant, as well as its leaves, are acrid and poisonous, containing *saponine*, but when ripe the tubers may be ground with water, and the starch so extracted used as food, as a kind of arrowroot. The Portland sago of Dorsetshire is the starch extracted from Arum tubers. The plant, though rare in Scotland, is common in England and Ireland in hedgerows, woods, and plantations. [J. L.]
[A. N. M'A.]

Arundo, an old name for the genus Phragmites, nat. ord. Gramineæ, to which the common reed belongs. See PHRAGMITES.

Arvicolinæ.—The Arvicolinæ or Voles constitute a sub-family of the Rodents or gnawing Mammals. They are allied to mice and rats, but may be distinguished from these by their generally thicker bodies, short heads with blunt snout, smaller eyes, shorter ears, legs, and tail. There are three British species: the Water Vole (*Arvicola amphibius* or *Microtus amphibius*), commonly known as the water rat; the Red or Bank Vole (*A. glareolus*); and the Short-tailed Field Vole (*A. agrestis*). They are almost exclusively vegetarian. The Field Vole has from time to time by excessive multiplication constituted a plague, proving extensively destructive to young grass, roots, and herbage generally. It inhabits pastures at all heights, favouring, however, low-lying moist situations. It lives in companies, burrowing at some depth, where breeding takes place and the winter supplies are stored. They are prolific animals, having ordinarily three or four litters in the year, each consisting of from four to ten young; sometimes in favourable years the pairing season may extend from February to November, when the young are in consequence greatly increased in numbers. The Bank Vole occurs usually in the neighbourhood of woods, living amongst the roots and stumps in banks. It climbs to some distance, feeding on buds, and frequently causing considerable damage. The Water Vole is destructive to grain crops, and the bark and roots of trees and shrubs on the banks of streams. Voles have numerous enemies; of those which are at the same time harmless to game and crops there may be mentioned owls, kestrels, buzzards, and the smaller seagulls. For methods of dealing with voles see the art. VOLES. [J. R.]

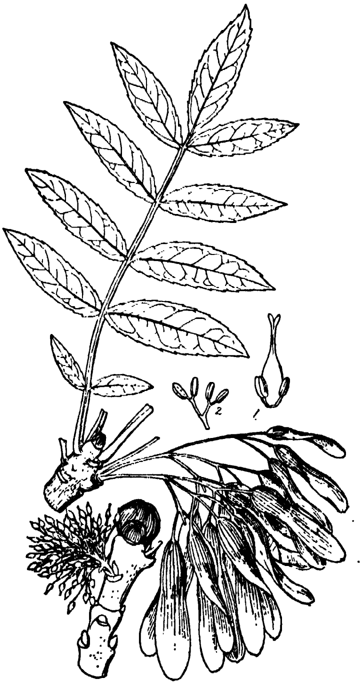
Asaphes vulgaris is a minute parasitic insect of the order Hymenoptera. The female punctures the wingless female aphides with her ovipositor, and lays an egg in each; these hatch into maggots, and eat out the inside of the aphis; they afterwards change to pupæ, and eventually the flies hatch and break through the dried skin of the aphis; the sexes pair, and the females again proceed to deposit eggs in the aphides. Now, as the parasites often swarm, and every female lays a considerable number of eggs, but only one in each aphis, and these are invariably females, it will be evident that they are agents which help to keep these pests in check. All the tawny, pearly, and black plant-lice on the wheat, turnips, &c., have been pierced by parasitic insects, of which there are an enormous number of different species in this country. The male of *Asaphes vulgaris* is an exceedingly minute creature, being only half a line long: the female is twice as large; the head and trunk are brassy-green; the body violet-black; the two antennæ and thighs are black; the knees and shanks, excepting the base, are ochreous; feet whitish, dusky at the tip; the four wings are transparent, with only one little nerve in the upper pair. [J. C.]
[F. V. T.]

Ascaris, an important genus of thread-worms (Nematoda) living in the intestine, especially the small intestine of vertebrates. Over 250 species have been described; almost all domesticated mammals serve as hosts to particular species. They are white, slender-bodied animals, tapering more or less to both ends, and progress, when they do move about, by coiling, twisting movements. They are mostly small; the largest known, *Ascaris megalocephala*, of the horse, may reach, however, to 38 centimetres. The following characters may be taken as diagnostic of the genus. There are three fairly large papillæ around the mouth, one of which is dorsal, the other two ventral. The male has two equal spicules and numerous papillæ in front of and behind the anus. The female opening lies in the anterior half of the body. The eggs are globular or ellipsoid. Pairing takes place within the body of the host; the eggs are expelled and may withstand desiccation for a considerable time. On reaching the intestine of a fresh host of the same species, generally amongst food or drink, the egg-shell is dissolved by the digestive juices and development proceeds. All the species probably develop without an intermediate host. *Ascaris lumbricoides* is one of the commonest human parasites, occurring all over the world; in temperate regions it is found most frequently in children. It is reputed also to occur in the pig. Though normally living in the small intestine, it not infrequently wanders into other situations, such migrations giving rise to serious symptoms. It is regarded by many as probable that Ascarides secrete a toxin. Experiments have shown that infection occurs partly through water, but chiefly by direct contamination from the soil. *Ascaris canis* (known also under a variety of other names—*A. mystax*, *A. marginata*, &c.) is a very frequent parasite in the intestine of dogs and cats; it is found also in various wild carnivora. It is commonest in young dogs about two or three months old. The male is from 5 to 10 cm. long, the female 9 to 12. The worms are white or reddish, with head usually curved and bearing two lateral expansions suggestive of an arrowhead. 'They inhabit the small intestine, and frequently the stomach, causing the vomition of glairy matter, in which they are found. Their presence is indicated by emaciation, unthrifty coat, enlarged abdomen, irregular appetite, sometimes symptoms of epilepsy or rabiform trouble, colics and constipation, or diarrhœa. In collecting in masses in the intestine they may cause complete obstruction, arrest the course of the alimentary matters, and induce invagination and fatal colic' (Neumann). As a remedy, santonin in 2 to 3 centigram doses in milk is most frequently given. *Ascaris megalocephala* is met with in the small intestine of the horse, ass, and mule. As a rule, the animal's health does not appear to suffer. The number of parasites in a single animal is very inconstant, varying from a few to many hundreds, in which latter case the animals are much more liable to suffer. Ill effects may result in such cases either from obstruction or from nervous disorders. Numerous remedies are in vogue, all of which are liable at times to prove ineffectual. Arsenious acid in increasing daily doses of 1 to 3 grams for ten days is frequently successful. In all species the number of eggs produced is large, and owing to their remarkable vitality and powers of resisting drying, are readily disseminated. Consequently the excreta of all stock known to be infected should be destroyed, and not allowed to contaminate manure pits. [J. R.]



Ascaris megalocephala (male)

Ash (Fraxinus), a genus of trees of the nat. ord. Oleaceæ or Olives, of which there are only two genera indigenous to Britain, the Ash tree and the Common Privet shrub (*Ligustrum vulgare*). The Ash forms a small genus of trees with pinnate leaves, limited to the non-tropical portions of the northern hemisphere. The only British species, and, in fact, the only species indigenous to Central and Northern Europe, is the Common Ash (*F. excelsior*), characterized by having imperfect flowers without calyx and corolla, though some exotic species have a 3- or 4-lobed corolla. It is a tall, handsome,



Common Ash (*Fraxinus excelsior*)

1, Hermaphrodite flower; 2, Anthers of male flower.

deciduous tree having light bluish-green, opposite, pinnate leaves with 7- to 11-toothed, ovate-lanceolate, sessile leaflets (though these are petiolated in most of the North American species). The flowers appear before the leaves flush, and look like clusters of stamens surrounded by a few small woolly scales springing from the opposite buds of last year's shoots. The fruits, which hang in clusters commonly called 'keys', are compressed capsules (samara) winged at the edges and the upper extremity, and about 1½ in. long. The Ash is found growing spontaneously from Scandinavia southwards throughout temperate Europe and Western Asia, although in the warmer regions of Southern Europe it is generally replaced by a variety perhaps entitled to be considered a separate species. For ornamental purposes it is one of the most beautiful of our woodland trees, although late in flushing its foliage and one of the first to shed its leaves at the touch of early autumn frost. In point of utility the Ash is second to none of our timber trees, especially to farmers, for though light (sp. gr. 0·88 green, 0·75 seasoned) its wood is the most pliable, toughest, and most elastic of all our timbers; and it can be used of any size, and for more purposes than any other kind of wood. The earliest description of rural economy (Master Fitzherbert's Book of Husbandry, 1534) well recommends that Ash should be cut 'between Martinmas and Candelmas', or immediately after the fall of the leaf; and it also even then advised, as regards the sale of wood or timber, 'if there be Ash in it, to sell the small Ash to coopers for garths [*i.e.* withes or hoops], and the great Ash to wheel-wrights, and the mean Ash to plough-wrights'. These varied uses of 370 years ago have continued to the present, for Ash can be used from the smallest size upwards, as walking-sticks, barrel-hoops, hurdle-withes; as tool- and fork-handles; as hop-poles, paddles, sculls, and oars; as spokes, shafts, and sides in carriages and carts; and as satisfying better than any other kind of wood the various requirements for agricultural implements, coach-building, and cart-making, as well as being good for furniture. The demand for ash-timber of good size is constant, and much larger than can be met by home-grown supplies at present. The finest Ash is that grown in the Midland English counties, and coach-builders there readily pay up to 5*s.* 6*d.* a cubic foot for good size and quality. Easily disposed of at all sizes, and quick in growth both as coppice and as a timber tree, Ash is on suitable soil and situation one of the most profitable hardwoods to cultivate. It is hardy, for although late spring frosts may nip its leading shoot (thus producing a forked growth with 'flowery grain' prized by the furniture-maker), its side buds developing later soon shoot ahead vigorously. It can be grown on most kinds of soil that are not dry and shallow, provided that the situation is not too high and exposed, though of course it thrives far better on a deep, fresh, light, loamy, and fairly well-drained soil than on a dry, sandy, or a stiff clayey soil; and it generally does uncommonly well where there is a large proportion of lime, as along the base of chalk-hills and near the margin of their streams and rivulets. Though it requires a large quantity of water for transpiration, it seldom does well as a timber tree unless the drainage is good, for it is only as coppice that it can endure anything like even temporarily stagnant water. On unsuitable soil or situation its stem and branches are soon apt to become black-cankered with fungous disease (*Nectria ditissima*), or to be attacked by scale insects (*Apterococcus fraxini* and *Coccus salicis*) and plantlice (*Chermes fraxini*), all of which parasitic diseases and insect attacks sometimes overrun and infest whole plantations.

The great recommendations for the growing of Ash in suitable localities are its easy cultivation, its rapid growth, its attainment of maturity at an earlier date than any of our other hardwoods, and the ease with which it can usually be sold at from 1*s.* 6*d.* to 2*s.* a cubic foot and upwards; while the quicker it grows, the tougher and the more elastic is its timber. It has from time immemorial been, along with oak and hazel, the chief kind of underwood grown in English copses. But now that the value of oak tanning bark and of woven hurdles of oak, hazel, &c., has greatly decreased, Ash usually forms by far the most profitable part of the crop, whether cut at 7 or 8 or else at 14 or 18 years old for hop-poles (where still used); and where it occurs pure, Ash is usually about the most remunerative form of coppice. It produces stout shoots freely, though suckers only to a smaller extent. But to attain good returns it should be grown without any standard trees, as the Ash is strong in its demand for light and freedom, although on good soil it can bear a fair amount of shade from thinly-foliaged standards. Its demand for light when of tree size is very apparent from the thinness of its foliage. This makes it suitable for a standard in copse, although its growth is not there so clean as in highwoods; but in the latter, thinning has to begin early (at about 20 years) in order to allow the crown to then expand during its most vigorous time of growth (20 to 40 years), and must be continued as occasion requires till the trees mature at from 50 to 70 years of age. As a hedgerow tree it is second only to the oak in importance, except in southern England, where it is often outnumbered by the elm; but it is usually the most easily saleable of them all.

Its cultivation is easy. It seeds freely almost every other year, and often springs up thickly in the woods, only to be eaten by rabbits. The keys can easily be gathered about the end of October or in November, if required for storing. As germination does not usually take place till the second spring, the seeds are generally stored for fifteen months by being mixed with dry sand (2 bushels of sand to 1 of seed) laid in a shallow open pit and turned over once every ten or twelve weeks, and are then sown on seed-beds with a covering of about ½ in. Transplanted as yearlings (at 6 by 6 in. or more), they can be put out after standing two years in the nursery lines, and easily establish themselves on good soil, though nurses (larch or pine) are sometimes desirable as a protection against frost in damp, low-lying situations. Its chief enemy is the rabbit, which is far more destructive to Ash in Britain than all the fungous diseases and insect pests combined; and where rabbits can get at Ash coppices, pole woods, or maturing trees, profitable growth becomes impossible. (For diseases, &c., see arts. below.)

The exotic species introduced into Britain are almost purely ornamental. The chief of these are the White Ash (*F. americana*), the Black Ash (*F. sambucifolia*), the Green Ash (*F. juglandifolia*), the Red Ash (*F. pubescens*), and several others from Canada and the United States. And in addition to these, numerous garden varieties have been obtained by cultivation, such as the Weeping, the Curl-leaved, and the Entire-leaved Ash, which are more quaint than beautiful or useful. [J. N.]

Ash, Fungoid Diseases of.—SEEDLING DISEASE.—Like all tree seedlings those of the Ash are frequently destroyed by fungi. A description of these, with treatment, will be found on another page (see BEECH—'Seedling Disease').

LEAF-SPOTS.—Numerous fungi have been described as causing Ash leaf-spot, and there is a fairly common form of downy mildew. Except perhaps in the nursery, none of these is destructive, and if need be could be kept in check by spraying with Bordeaux mixture.

ASH CANKER.—The frequency of this disease in some districts, compared with its rarity in others, suggests that conditions of growth are important predisposing influences. Canker shows itself first as small wounds, round which the bark, instead of healing over, becomes thickened and wrinkled. In course of time the wound enlarges, and the centre becomes a mass of decaying wood which can be traced deep into the tree. Accompanying the wound one can generally find the fungus (*Nectria ditissima*), which causes apple canker (see APPLE). This fungus has been found in the living tissues of the wood and bark of Ash, and the spore-producing capsules make their appearance on canker-spots or on dead branches; they are bright-red or dark-red, and about the size of a small pinhead. The fungus finds admission through broken or injured twigs and other wounds. Where the Ash is grown in plantations the application of remedies is probably out of the question because of expense, and more success will result by abstaining from growing Ash where the canker is known to be prevalent.

HEART-ROT OF TIMBER.—The deterioration of timber is another source of loss which follows soils, in some districts appearing early, in others only injuring old trees. The appearance of the bracket-like fructifications of various Polypori on the bark is a sure sign that heart-rot is going on in the timber. One of these (*Polyporus hispidus*) is easily known by its thick brown fructifications, which may measure a foot across; the rot caused in the timber is brown with white lines, and the trees become hollow. Other species of Polypori cause either red or white rot. The only way to avoid loss from heart-rot is to fell the timber as soon as it begins to be unsound. [W. G. S.]

Ash, Insect Enemies of.—The following are the chief insect pests of the Ash tree:—*Hylesinus fraxini*, the Ash Bark Beetle; *Chionaspis salicis*, the Ash Scale; *Melolontha vulgaris*, Cockchafer; *Apterococcus fraxini*, the Felted Ash Coccus; *Cossus ligniperda*, the Goat Moth; *Zeuzera æsculi*, the Wood Leopard Moth. See the specific arts. HYLESINUS, &c.

Ash, Volcanic.—When molten rock, associated as it is with superheated water, rises in the throat of a volcano, the water may suddenly pass into steam and blow the lava-crust above it, and part of the molten matter, into the air. Thus *volcanic bombs*, with rapidly cooling surfaces, and rough vesicular *scoriæ*, torn from consolidated lava, are flung hundreds of feet into the air, striking against one another and producing a fine dust, which is sifted out before the wind. This material, though not a product of combustion, is known as *volcanic ash*. The very glassy scoriæ, styled pumice, produce the finest ash, which may be carried hundreds of miles from the place of eruption, and may yet fall as a recognizable shower. Crystals of the minerals common in the original lava of course occur associated with the glassy or more stony material of volcanic ash.

During a great eruption, such as that of Vesuvius in April, 1906, the whole surface of a country may be changed in a few hours. Trees are stripped of their leaves, grass and crops are buried, and a uniform grey or grey-white colour spreads across a landscape that was before bright with villages and variegated farmlands. The new finely divided material, however, may not be harmful in itself, and successive deposits have built up regions of rare fertility. The composition of these soils is naturally as varied as that of the lavas which give rise to them. The absorbent yellowish *Trass* of the Brohltal and other valleys of the Eifel in western Germany is a deep deposit of trachyte ash. The trachytic and basaltic ashes thrown out by the volcanoes of Auvergne above Clermont Ferrand require irrigation if they are to be advantageously cultivated; but M. Risler (Géol. agricole, vol. ii, p. 406) points out how the dust blown or washed from them has enriched with lime, phosphoric acid, and potash the deposits of lakes and rivers in the lower ground, from Oligocene times onward.

In the coarser ashy soils, water may be too rapidly absorbed and drained away, unless a certain amount of decomposition has set in, promoting the growth of clay. But the peculiar wisp-like forms of the particles, and their highly vesicular nature, offer a large surface to the vegetable agents of disintegration. Ancient volcanic ashes, like those of Cader Idris, may become thoroughly compact and even flinty, and our British ashes thus yield soils similar to those of the old lavas associated with them. See also TUFF.

[G. A. J. C.]

Ash Manure is composed principally of the ashes obtained from the burning of coal and wood. In addition they generally contain, mixed with them, the refuse animal and vegetable substances that accumulate from culinary and other household processes. The contents of the ashpit, dustbin, &c., really constitute what is sold as ash manure. It may also contain human excreta removed from dry earth-closets.

Considerable quantities of ash manure are produced in large towns, which are purchased by farmers and used as a manure. Being composed of such varied material, its composition is naturally uncertain: certain amounts of potash and phosphates are supplied by the ash, whilst the refuse animal and vegetable matter contains some combined nitrogen.

It may frequently be found to contain considerable admixture of earth and unburnt carbon; also it may happen that in the incineration of coal and wood, &c., the temperature may rise so high that some of the constituents fuse or melt, and when cold set into hard, glassy lumps. The presence of these vitreous lumps deteriorates the value of the ash as a manure.

The mineral matter in the ash, besides acting as a plant food, exerts an important mechanical action upon strong clay soils. The power it possesses of neutralizing acids is also of great value when applied to sour soils.

Ashes are useful for mixing with other manures in making composts, &c.

In addition to ash manure, various by-products obtained in different manufacturing processes and from sewage-purification works are now produced, and used by farmers in the neighbourhood of large cities. See arts. MANURES, GARBAGE, SEWAGE SLUDGE.

[R. A. B.]

Ash of Plants.—The largest constituent of growing plants is water; most farm crops in the green state contain between 75 and 90 per cent of their weight of this substance. On drying them the water evaporates, and the material left is called the dry matter. If the dry matter is then burnt in air, the greater portion of the substances of which it is composed disappears as colourless gases or vapours, leaving behind a residue called ash. That part which burns away forms the combustible portion, and consists of all the complex compounds of carbon, whilst the incombustible part, namely the ash, comprises the mineral matter contained in the plant. The constituents of the ash are obtained by the roots from solution in soil water; only very minute amounts, however, of these mineral ingredients exist therein, so that plants require to take up through their roots considerable quantities of water in order to obtain the requisite amount of mineral food. The ash forms but a comparatively small portion of a plant, and the amount varies in different plants and in different organs of the same plant. Thus the grain of cereal crops contains about 2 per cent of ash; straw about 5 per cent; turnip roots contain about ·7 per cent; leaf about 2·0 per cent; wood about ·4 per cent.

The following components are always found in the ash: potash, lime, magnesia, phosphates, iron, and sulphur. These are absolutely essential to the life of a plant. In the process of growth, plants take up considerable amounts of mineral substances which are not essential; thus, in addition to the above we find manganese, silicon, chlorine, iodine; very rarely aluminium and zinc, and traces of rarer metals. These latter series of elements, though they do not appear to be indispensable to vegetable growth, may nevertheless perform useful functions, and thus contribute to the wellbeing of a plant.

The qualitative composition of the ash does not quite represent the same state of chemical combination as that originally existing in the plant before incineration. The bases in combination with sulphuric, phosphoric, hydrochloric, and silicic acids appear in the ash, however, practically in the same form, whilst those in combination with nitric and organic acids, &c., are found as carbonates, the original acids being destroyed in the preparation of the ash. Slight losses in the potash and soda may also arise through the volatilization of the chlorides of these bases during the same process, and for the same reason the sulphur and phosphorus in combination with vegetable compounds may undergo partial loss.

Considerable variation in the percentage composition of the components of the ash of plants is found to exist. This variation is due to a number of factors. In the first place, to wide differences in the assimilative powers of the roots of plants belonging to different families. Those belonging to the order Gramineæ, which include the grasses and all the cereal crops, take up considerable amounts of silica, whereas root crops contain very little of this substance; on the other hand, more potash and soda are found in the ash of the latter than in the former. Mosses contain the element aluminum, rarely found in any other plant. Turnips have greater difficulty in attacking and assimilating the combined phosphates in soils. Differences due to variation in the character of soil, manuring, and season are also very marked; thus the ash of wheat straw grown on soils near the coast contains more soda than when grown inland; but similar differences are even more noticeable with succulent crops, where the relative proportion of each constituent is largely governed by their abundance or scarceness in the soil on which the crop is growing. Appreciable variations exist according to the stage of ripeness; as the plant matures generally the ash contents increase.

Though considerable variations are shown to exist in the plant as a whole according to divergent circumstances, this variation is not extended to the same extent in the seed, which is found for all plants to possess a very constant composition.

The function of the ash constituents is not yet clearly understood. After being absorbed into the sap through the roots, they appear to concentrate in different organs in the plant. It is invariably noticed that wherever growth is in active progress, potash and phosphates are always found to predominate. These same two constituents, as the plant matures, migrate towards the seed, of which they constitute the greater part of the ash. Their abundance in the soil tends to the greater production of, and to hastening the maturation processes in seeds. Obviously, ample supplies of these ingredients are indispensable for proper development of healthy plants. Iron, lime, magnesia, and sulphur are likewise equally as essential to the plant for the performance of their respective functions.

The ash of stems, leaves, and husks of gramineous plants are rich in silica and potash, but poor in phosphate. Though silica does not appear to be indispensable, it, however, aids in hardening the tissues in which it occurs. At one time it was thought to be necessary for the stiffening of the stems of cereal crops, but that is now shown not to be the case. Recently an important function has been attributed to silica by A. D. Hall, from experiments conducted at Rothamsted. From these results, silica appeared to be a valuable factor in the assimilation of phosphorus by grasses and barley. When in solution it seems to impart a stimulus for the absorption of phosphates by these plants. The result of an application of sodium silicate to barley was to increase the yield of grain and the amount of phosphates in the ash, also to hasten the ripening of the corn.

Calcium and magnesium, as salts of vegetable acids, are found deposited in crystalline masses in certain cells, also along with silica in the leaves. Of the soluble salts remaining in the sap unused, sodium appears to predominate. Soda and potash are chemically closely allied, but they are not mutually interchangeable as food for plants, though in absence of sufficient amounts of potash larger quantities of soda are taken up; but in no case has it been proved that soda can entirely replace potash as a food. The explanation of the accumulation of soda in the sap and of the comparative absence of potash is the fact that potash is removed from solution, whilst soda is not removed and stored to the same extent in the reserve organs of plants. By this means plants are able to exercise a selective power between the two bases. As the potash is removed from the sap and stored away, fresh supplies are taken up by the roots from the soil, and this drain continually goes on during growth. With soda, on the other hand, a concentration soon takes place in the sap, and when a certain strength is attained no more will diffuse through into the roots from the soil water. For this reason the drain on the sodium salts in a soil is comparatively soon brought to an end during the growth of a plant.

Chemical analyses have now been made of a very large number of plants. Of the agricultural plants, it will be seen from the following table that well-defined differences on an average are noticeable between the crops belonging to different families, while a close agreement exists among the crops of the same family. Separate analyses of the seed, stem, and leaves have been made, which makes it possible to calculate, when the weight of produce is known, the quantity of ash constituents removed by the different parts of crops, and to supply information upon the degree of exhaustion suffered by the soil.

The amount of mineral constituents removed from the soil by different crops varies enormously. Taking phosphates and potash, the following figures give in lbs. per acre the quantities removed by an average crop of—

	Potash.	Phosphoric Acid.
Wheat, grain, and straw ...	28·8 lb.	21·1 lb.
Meadow hay	50·9 ,,	12·3 ,,
Red clover	83·4 ,,	24·9 ,,
Turnips with leaf	148·8 ,,	33·1 ,,
Mangel with leaf	300·7 ,,	52·9 ,,
Potatoes	76·5 ,,	21·5 ,,

For particulars of manuring, and for further information on crop peculiarities in regard to their mineral requirements, the reader must consult the article on MANURES AND MANURING.

ASH CONSTITUENTS OF PLANTS (WOLFF).

Percentage Composition of Ash.

	Total pure Ash.	K_2O.	Na_2O.	CaO.	MgO.	Fe_2O_3.	P_2O_5.	SO_3.	SiO_2.	Cl.	Ash in Plant.
Wheat grain	100	31·16	2·07	3·25	12·06	1·28	47·22	0·39	1·96	0·32	1·8
Wheat straw	100	13·65	1·38	5·76	2·48	0·61	4·81	2·45	67·5	1·68	5·3
Bean grain	100	41·48	1·06	4·99	7·15	0·46	38·86	3·39	0·65	1·78	3·2
Bean straw	100	43·26	1·70	26·63	5·71	1·27	6·37	3·91	7·01	4·39	5·4
Red clover in bloom	100	32·29	1·97	34·91	10·90	1·08	9·64	3·23	2·69	3·78	1·6
Mangel root	100	52·2	16·26	3·73	4·30	0·75	8·53	3·02	2·04	9·96	1·0
Mangel leaf	100	30·71	19·44	10·65	9·53	1·41	6·50	5·62	3·63	15·98	1·8
Potato leaf	100	60·06	2·96	2·64	4·93	1·10	16·86	6·52	2·04	3·46	1·0

[R. A. B.]

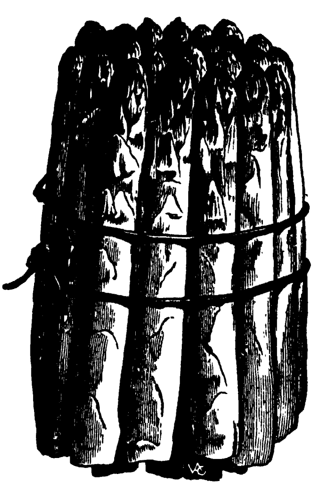
Ashpit.—An ashpit, for the purposes of the Public Health Acts, includes any receptacle for the deposit of ashes or refuse matter, whether the same be fixed or movable. The owner or occupier of every house or part of a house occupied by a separate family must provide a sufficient fixed or movable receptacle for rubbish, and must keep it so as not to become a nuisance. If any ashpit is allowed to become a nuisance or injurious or dangerous to health, summary proceedings may be taken under the Public Health Acts to abate the nuisance, or the party aggrieved may proceed to enforce his common-law rights. [D. B.]

Ash Weed, the only native species of the genus Ægopodium, nat. ord. Umbelliferæ, more commonly known as Bishop's weed. See BISHOP'S WEED.

Asopia farinalis (the Meal Moth).—This pretty moth measures nearly 1 in. in wing expanse, but is often much smaller; the base and apex of fore wings are reddish-grey, brightest towards the upper edge, on each inner border of the dark areas is a fine whitish wavy line, the intervening space being rich yellowish-grey; hind wings grey with two wavy white lines. The caterpillar is pale, with brown head and plate on the first segment; it feeds on flour, bran, corn, and straw, and often does much harm. It lives in the dark and constructs long tubes composed of particles of dust, flour, and meal, spun together with silk. The caterpillars exist from autumn onwards until the summer of the second year, when they pupate in white silken cocoons. They are most annoying in granaries and stores.

The only method of clearing them out is fumigation. Granaries should be well cleaned down once a year, and meal, &c., kept in closed bins, not sacks. [F. V. T.]

Asparagus (*Asparagus officinalis*), a hardy perennial of the great lily family, and a native of Europe and Asia. It grows wild in Essex and Lincolnshire, and in great plenty near Harwich, and is now naturalized in America. Pliny states that asparagus was in his time carefully cultivated in gardens, particularly at Ravenna, where it was grown so fair and large that three shoots would weigh a pound. The plant consists of a cluster of fleshy roots, from which spring annually tall slender shoots branched and clothed with bright-green leaves and star-shaped white flowers followed by bright-red pea-like berries. The portions used as food are the young undeveloped stems, the colour and thickness of which depend largely upon the character of the soil and the method of cultivation. Being naturally a seaside plant, the best asparagus is grown in gardens and fields near the sea where there is a good depth of sandy soil. In Holland and Belgium hundreds of acres are devoted to its cultivation in districts where the soil is of a very sandy character, and this is the sort of soil that the plant prefers, a heavy, close, or clayey soil being unfavourable. Heavy soils may be made suitable by deep digging and breaking up. The big shoots produced in France are grown on a loamy soil. The ground must be drained well enough for vegetable culture generally, which is all that is needed for asparagus culture. The plant enjoys moisture, but it must not be stagnant, and the asparagus has a decided liking for a little salt. Cultivation has greatly improved the thickness and flavour of the shoots. If a new bed is to be made, deep trenching is the first operation. This need not be the excavation of grave-like holes, as sometimes recommended, but turning two spits over and then breaking up the bottom of the trench. Before turning in the first spit a 6-in. layer of well-rotted stable manure should be spread in the bottom of the trench. In sandy soils this deep digging may be dispensed with, as the roots of asparagus do not descend more than about a foot below the surface. The bed need not be higher than the surrounding ground except where the soil is heavy, when the beds should be 5 ft. wide and 6 in. higher than the path. In some parts of this country, in close proximity to the sea, land which was unsuitable for ordinary farm crops has been turned to profitable account by deep ploughing and heavy manuring, and then planting it with asparagus a year old, set a foot apart in rows 2 ft. apart, opening a trench deep enough to take the roots and allowing the crown of the plant to be 3 in. below the surface when the soil was filled in. It is waste of labour to transplant old roots; they survive the operation, but they never produce good stems after it. Transplants should not be more than two years old, some experts preferring one-year plants. The roots should be spread out horizontally and evenly at the time of planting. The most favourable time of year for this work is April or May. For a year after planting all that is needed is the weeding of the beds and the breaking up of the surface with a hoe. In very dry weather water must be given, and it is helpful to cover the beds with a layer of light manure or, where obtainable, seaweed. In the following spring the beds are lightly forked over and again mulched. For the first three years after planting every shoot must be left on the plants to enable them to make vigorous growth and form a stout root system from which strong shoots may be expected. As growth proceeds, the plants require the assistance of stimulants such as liquid manure, if easily obtained from the farmyard, or the covering of the whole bed in April with a 3-in. layer of well-rotted horse droppings. For large plantations seeds may be sown in the beds, and the seedlings thinned out



Asparagus—Giant Dutch Purple

to the distance apart recommended for transplants. The seeds should be sown in April, 2 in. deep. Nitrate of soda is an excellent help to asparagus, and serves well enough on soils that are good. It should be given at the rate of 100 lb. per acre early in April, and a second supply at the same rate in May. The effect of the nitrate is the same as that of salt, and it is quite as cheap and easy of application. Whether nitrate or salt is used it should be broken fine before being spread over the bed. Some growers prefer sulphate of magnesia for asparagus, applying it in June at the rate of 20 lb. per 100 sq. ft. Salt is applied at the same rate and time. The following table shows the effect of these three stimulants on the produce of asparagus beds, the comparison being with beds that had received no manure:—

	Increase: First Year.	Increase: Second Year
Nitrate of soda	18	84
Sulphate of magnesia	44	43
Salt	22	—

The advantage salt has as a dressing for the beds is in its effect on weeds, most of which it destroys. Salt should not be used for heavy soils.

To obtain long blanched shoots a mound 6 in. high of fine light soil should be placed over each crown in early spring, and over the bed a 6-in. covering of manure litter. The shoots are ready to be cut as soon as they appear above the surface, and they may be cut as often as they are required until early July at the latest, when cutting should cease. If cutting is continued later than this, the plants will be weakened in consequence. A well-managed bed will last twenty years, and yield annually a good supply of shoots. The sorts most favoured by English cultivators are: Giant Dutch, White German, and Early Giant d'Argenteuil. The last named is the well-known French Asparagus, which has very thick white shoots, but it is doubtful whether it is better as a food than the smaller green-shooted sort grown in England. See also following arts. [W. W.]

Asparagus, Insect Enemies of.—*Crioceris asparagi*, the Asparagus Beetle; *Platyparea pœciloptera*, the Asparagus Fly. See these articles.

Asparagus, Parasitic Fungi.—

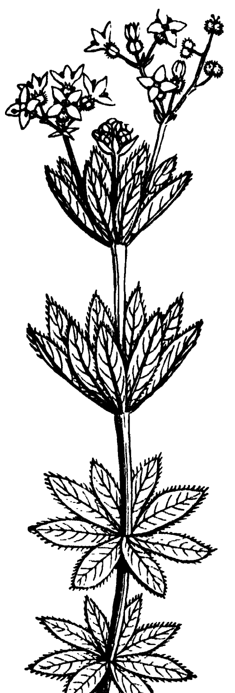
ASPARAGUS RUST (*Puccinia asparagi*) is not often heard of as a pest in Britain, but in market gardens in the United States it has devastated whole fields. The rusted plants show blister-like spots on the skin of the stem, and these give off brown or black spores which are either uredospores, teleutospores, or æcidiospores; the fungus is therefore one of the rust fungi, which, like mint rust, produces all its forms of spore on one and the same host-plant. The simplest remedy is to collect all stems as soon as possible, and burn them before they have time to discharge the spores over the soil; if the disease has shown itself, this practice should be kept up every year. Bordeaux mixture has also been used after the crop of young shoots has been collected, but the results have not been completely satisfactory.

ROOT-ROT, accompanied by a dark-coloured fungus (*Rhizoctonia*) which invests the roots in a mass of filaments, attacks asparagus, beet, carrot, crocus, and other plants. The only remedy is to dig up the bed, apply quicklime, and change the crop. [W. G. S.]

Aspect.—The aspect of land with reference to the direction or incidence of the sun's rays has an important bearing on the productiveness of soils. See EXPOSURE.

Aspen.—A tree of the same genus as the White Poplar, characterized by having the leaf stalks particularly slender, so that the blade trembles with the slightest motion of the air. See POPLAR.

Asperula odorata (Woodruff).—This is a woodland perennial herbaceous plant, of the order Rubiaceæ, remarkable for the very agreeable perfume which it emits when drying. This perfume, like that of Sweet Vernal Grass, is due to the presence of *cumarine*. The plant has a creeping underground stem, with unbranched angular air stems 6 or 8 in. high, and narrow lanceolate leaves, arranged in whorls of about eight, at each node. The leaf edges bear fine hooked bristles, which cause the leaves to stick to the skin. The white flowers grow in little terminal cymes. The corolla is pure white, of funnel shape, and divided into four equal lobes. The stamens are four, and the pistil is composed of a two-lobed style, seated upon a double inferior ovary, which changes into a hard two-lobed fruit, covered with short bristles.



Woodruff (*Asperula odorata*)

There is another sort of woodruff called Squinancy wort (*Asperula cynanchica*), common on the chalky downs of England. It has straggling stems, small heath-like leaves, four in a whorl, and pinkish flowers, followed by a small double granulated fruit.

[J. L.]
[A. N. M'A.]

Asphalt, or native bitumen, like naphtha, petroleum, and mineral tar, is believed to be of vegetable origin, and to have been formed by the slow decomposition of organic matter under marine or lacustrine conditions. Pure asphalt is a black or brownish-black solid possessing a sharp, bright, conchoidal fracture. It fuses at 100° C., emitting a strong smell of pitch, and burns with a bright but very smoky flame. Sp. gr. 1 to 1·2. Its proximate constituents vary according to quality, but in greater or less percentages naphtha or light oils, heavier hydrocarbons not vaporizable below 100° C., resins, and kindred organic bodies are present.

Asphalt in a very pure state was formerly found in considerable quantity on the shores of the Dead Sea, hence called *Lacus Asphaltites*. Pure asphalt also occurs at Avlona, in Albania, at Caxatambo in Peru, in Cuba, and the famous great Pitch Lake of Trinidad. Of greater importance industrially than the pure asphalt is what is known as asphalt rock, a limestone impregnated with bitumen in the proportion of about 8 parts of the latter to 92 of the former, although the richest samples, those from the Val de Travers, canton of Neufchâtel, Switzerland, contain as much as 20 per cent bitumen. This rock is exploited at the Val de Travers, also at Seyssel, department of Ain, France, and at various other mines in France and Germany, and to a less extent in Spain.

Asphalt is very extensively used for paving and roofing purposes, and owing to its elastic nature, which enables it to give way to changing strains without breaking, it is one of the best materials to use for damp courses in buildings. In France it has also been used as a lining for the walls of stables, for which its toughness and elasticity peculiarly adapt it, the liability to injury from kicking being thus lessened. Two methods of laying an asphalt surface are in vogue: (1) the mastic process, and (2) the hot compressed process. The former consists in boiling up together finely ground asphalt rock with a proportion of tar and fine sand, and pouring the molten mass over the prepared surface—usually concrete—to the required depth. The surface is then levelled and sanded. The latter method is perhaps the one more commonly employed. Hot powdered asphaltic stone is spread on the prepared surface, and hard pressed till it forms a homogeneous elastic coating. Asphalt mastic is ductile and elastic, and consequently very durable, is smooth, easily kept clean, and has the advantage of being comparatively noiseless. It is easily laid down and easily repaired. An objection has been urged against it on the ground of the slippery nature of the surface so prepared, thus rendering its use in the stable a source of danger. In this respect it is decidedly inferior to a flooring of well-dressed whinstone setts, but it has the advantage, in some districts at any rate, of cheapness.

When an excess of tar is used in the mastic process, the melting-point of the material is considerably lowered, and when used in this condition for flooring byres, has been known to be softened from the heat of the cows' bodies, causing the adherence of the hair of the animal.

In addition to its main use as a paving material, asphalt is also industrially applied to the manufacture of roofing felt and drain pipes of compressed paper. [J. B.]

Aspidiotus ostreæformis (the Oyster-shell Bark Louse).—A scale insect or Coccid which encrusts the bark of plum and other fruit trees, sucking out the sap and causing endless harm. It is shaped like a miniature native oyster shell; flattened, smooth with concentric markings, grey to black with a small black spot slightly out of the centre. They thickly encrust the bark, producing a scurvy appearance. The insect beneath is yellow, and is found during the winter; the females are permanent under the scale; the males are winged, and hatch in April and May; the male is yellow with transparent wings. The females lay eggs under the scales in May and June, which soon hatch into little active larvæ which wander over the trees; sooner or later they settle down, and the scale is gradually formed over them.

Treatment.—Spraying with paraffin emulsion in winter at the rate of 6 gals. of paraffin, 5 lb. soft soap, to 100 gals. of water. Young stock should be fumigated with hydrocyanic acid gas before being planted. [F. V. T.]

Ass. — All the breeds and strains of the domestic ass — *Equus asinus*, L. — are believed to have descended from the wild ass (*E. tæniopus*) of Nubia, Abyssinia, and other parts of north-east Africa between the Nile and the Red Sea. If this view is correct it follows that the domestic ass, though doubtless related to the wild ass of Somaliland (*E. somaliensis*), has sprung from a single wild species, and is hence distinct from the Asiatic asses, *i.e.* from the Kiang (*E. hemionus*) of Mongolia and Thibet, and the Onager (*E. onager*), varieties of which occur in Turkestan and Persia, north-west India, and Syria.

When and where asses first made their appearance on the scene it is impossible to say, and it is also impossible to say when asses were first domesticated, or in what relation they stand to horses and zebras. It has often been pointed out that in make the Nubian ass resembles the Mountain Zebra (*E. zebra*) of South Africa and Angolaland, and that the Kiang in colour as well as in make resembles the wild horse (*E. prejevalskii*) of Mongolia; but we are not yet in a position to say that the African wild asses are closely related to zebras, or that the Asiatic wild asses and Prejevalsky's horse are offshoots from the same branch of the Equidæ family. That the ass was domesticated about the same time as the horse is suggested by the recent discovery of a statuette in a Lourdes cave, which is believed to represent an ass provided with a halter. This ivory statuette seems to belong to the same section of the Early Stone Age as the carvings from Saint Michael d'Arudy representing horses wearing elaborate halters.

The ass was evidently used in Egypt long before the horse; it played an important part in Homeric Greece; and though the Arabs were late in acquiring horses, they seem to have possessed asses from time immemorial. That the domestic asses of modern times have all sprung from the Nubian ass is extremely probable; nevertheless it is quite possible that just as the African elephant was once domesticated, one of the Asiatic asses may have for a time lived under domestication. This view is supported by a bas-relief found at Nineveh by Layard, which represents the capture of a wild ass of the Onager type, a species which once existed in the south of Russia, and probably also during historic times in the valley of the Danube. Further evidence in support of the domestication of the Onager we have in the fact that Indians in the army of Xerxes had chariots drawn by asses, and from asses being used in war in Carmania, an ancient province which included modern Persia.

The domestic ass, *i.e.* the variety said to have sprung from *E. tæniopus* of Nubia, seems to have been late in reaching Europe. According to Aristotle the ass was unknown in his time in Pontus or Scythia and in the country of the Celts (France and Germany), and there is no evidence that it reached England before the days of Ethelred, or that it was common before the end of the 17th century. Asses are easily distinguished from horses living under domestication, but the difference between, say, a Kiang and the wild horse of Mongolia is not so obvious, for in Prejevalsky's horse, as in the ass, the mane is short and upright, the face is bent downwards on the cranium (*i.e.* there is a convex or ram-like forehead), and there are only five lumbar (loin) vertebræ. Moreover, in the wild horse of Mongolia the tail and hoofs are more asinine than equine. But while Prejevalsky's horse is at least mule-like in many of its points, it differs from asses in having shorter ears, smaller nostrils,[1] and a complete set of callosities—in asses the hind chestnuts are absent; further, instead of braying it neighs like an ordinary horse.

From the common horse asses not only differ in the ears and nostrils, mane, tail, hoofs, and callosities, but also in the skull and vertebral column. In a forest horse, *e.g.*, there is a long flowing mane, part of which forms a forelock, a full tail with long hair up to the root, broad hoofs, a complete set of callosities, a skull with the face (which is short and broad) in a line with the cranium, and the spinal column provided with six lumbar vertebræ. In horses of the Celtic and Libyan varieties, in addition to differences in the skull, mane, and tail, &c., there are differences in the callosities, for, as we now know, in these varieties the four ergots (fetlock callosities) as well as the hind chestnuts are absent.

With the exception of the nearly white lips and muzzle, a typical domestic ass, like its Nubian progenitor, when seen from a distance appears to be of a nearly uniform grey colour, relieved by a dark dorsal band and a shoulder stripe, and in some cases by bars on the legs. A closer examination, however, reveals the fact that the under surface of the body, the inner aspects of the legs above the knees and hocks, and the lining of the ears are of the same light-grey tint as the muzzle, and that in addition to an irregular light band round the middle of the ear there is a light ring round the orbit. Sometimes the Nubian ass, instead of being grey, is of a rufous colour, like the Kiang. Ordinary mules are also frequently of a brownish-yellow colour and provided with distinct bars on the legs, as in the ass of Somaliland. From a study of zebra-ass hybrids as well as ordinary mules and hinnies, one is led to surmise that the common ancestor of the asses was of a rufous or foxy-red colour, with distinct bars on the legs and numerous narrow, ill-defined stripes on the head, neck, and body, and perhaps spots on the hind quarters.

Horses living under domestication vary greatly in their coloration, but the domestic ass is nearly as conservative in its colour as the wild horse. It may be white or black (as wild animals may be white or black), but with rare exceptions it is some shade of grey, without either a star or blaze, white 'stockings', spots, or blotches, or any suggestion of bright bay, red-dun, chestnut, or blue-roan. Of numerous asses noticed during a recent journey in the West Indies and Mexico only two were piebald, and only one had a blaze.

The dorsal band and shoulder stripe, though rarely absent in grey specimens, vary considerably in colour and width; the shoulder stripe may, moreover, be very short, or long and forked as in zebras, or represented by two or more stripes at each side. The mane, usually dark, varies in length according to the season, but the hairs seldom exceed a length of 4 in.—in rare cases a few locks of fine hair hang over the forehead or fall to one side of the neck, but this only happens when portions of the mane are not shed with the winter coat; when, as in the Poitou ass, the coat is retained for several years, there may be a distinct mane and forelock. The base of the tail is covered with hair like that on the hind quarters, but the middle portion carries somewhat longer hair, while the tip of the dock usually carries hair from 6 in. to over 20 in. in length; as in the wild horse, the dorsal band extends some distance along the tail. In well-bred Eastern asses the coat in summer consists of short fine hair, and of only slightly longer hair in winter; but in cold areas the coat of the ass differs but little from that of indigenous horses living under natural conditions, the outer coat sometimes reaching a length of 4 or 5 in. In some cases long hairs which appear on the forehead and above the orbits to some extent make up for the absence of a forelock.

Asses having been specialized for an upland life—the Kiang, *e.g.*, frequents valleys 12,000 to 15,000 ft. above the sea level—the hoofs are long and narrow, with sharp, hard margins and long 'heels', between which lie the elastic, bulbous portions of the frog which first reach the ground in walking. The hoofs instead of spreading, as in the broad-hoofed forest horse, often diminish slightly from above downwards, with the result that they are narrower where they rest on the ground than at the upper border or coronet.

In the horse the fetlock callosities often take the form of long, curved, spur-like projections (hence the name ergots), but in the ass they retain the form of pads, doubtless because they are still functional. In a 10-hands domestic ass the front ergots (oval convex structures) are likely to be 15 mm. (over ½ in.) wide and 25 mm. (1 in.) long, while the hind ergots, about the same length, may be slightly wider. Though smooth and soft at birth, the fetlock pads are usually hard and more or less fissured in the adult. In the horse the front chestnuts—oval, elastic, and slightly prominent pads at birth—usually develop into large, hard, horny, irregular structures which often project 1 in. or more beyond the level of the skin. In the ass the front chestnuts take the form of dark, smooth, thin, horny plates, which never project beyond the level of the skin. In a 10-hands ass the front chestnuts generally measure 38 mm. (1½ in.) in length and 37 mm. in width. Compared with a horse, the front chestnut is nearer the elbow, *i.e.* it has migrated farther than in the horse from its original position at the wrist—a position it retains in the dog and other carnivora. The ass, like Prejevalsky's horse, as already indicated, has an arched or ram-like forehead and the ears placed far back. When a domestic ass 10 hands high is compared with a Shetland pony of the same height, it is found that in the ass the head, in addition to being more convex above the level of the eyes, is longer and narrower (especially at the muzzle), the difference in length being due to the ass having a longer face. In an ass with a head which measured over 17 in. from the occipital crest to the base of the upper incisor teeth, the ears measured over 9 in., *i.e.* more than half the length of the skull, including the incisor teeth; whereas in a Shetland pony of the same size the ears measured under 5 in. In horses the length of the ear bears no relation to the height at the withers[1]—a tall horse may have short ears, while a small horse may have long ones—but in the domestic ass the length of the ears is intimately related to the height. They usually measure over 9 in. when the height is 10 hands, over 11 in. when 12 hands, and over 12 in. when the height at the withers is above 14 hands. By having the ears unusually long, an ass may be better able to discover in which direction his enemies are approaching. Although the face in the domestic ass is bent on the cranium, as in sheep, the outline from the level of the eyes to the muzzle, instead of being convex as in the Kiang and the wild horse, is usually slightly concave. In the ass the neck is short, the shoulders upright, and the withers flat and decidedly lower than the croup—even in a 10-hands specimen the croup may be 2 in. higher than the withers. The croup usually droops considerably, hence the tail, though in a line with the backbone, is set on low. The limbs are, as a rule, slender and well formed. In a 10-hands ass the circumference below the knee may be only 5 in., and in a 12-hands specimen well under 6 in., whereas in a 10-hands Shetland pony the 'bone' may be over 6 in. The metacarpal (front cannon) bone, as in slender-limbed horses, is so narrow that the length is 7·4 times the width; in a horse of the forest type, in which the 'bone' is round, the length of the metacarpal may be only 5·4 times the width. When, as in the large Poitou ass, the back tendons are (as the result of artificial selection) well clear of the metacarpal, the 'bone' is flat, and may measure over 8 in. below the knee. The limbs, like the hoofs, have been specially modified for moving with great precision and at times at considerable speed along narrow, rugged mountain paths. Notwithstanding the upright shoulders, low withers, and slender limbs, an ass is capable of carrying or hauling much heavier loads than a horse of the same weight and size, and of plodding on for a much longer time without either food or water. Asses, like goats, are capable of finding sufficient food where most animals would starve. Probably for this reason they have in some countries been left to shift for themselves, with the result that they are now often dwarfed and badly made. In India, for example, where the ass leads a very hard life (is, in fact, as a rule an outcast at the tender mercy of the potter and washerman), it often only measures 30 in. at the withers. But when well fed and cared for, the domestic ass often reaches in Europe a height of over 14 hands, while in America, by careful selection from amongst the descendants of asses introduced from Europe, some strains now measure nearly 16 hands. In other words, under unfavourable conditions asses may be as small as the most diminutive Shetland ponies, while under favourable conditions they may be as large as a Clydesdale.

---

[1] The nostrils of the ass are often slit in Persia, India, and Malta, in order, it is said, to make breathing easier.

In addition to feeding on grass, asses often browse on thistles and other thorny plants, and they seem especially to relish bitter and lactescent herbage, and to prefer brackish to fresh water. The common ass has the habits one associates with animals adapted for a lonely upland life. It avoids marshes, refuses to cross streams, but enjoys rolling in the dust, and finding its food on the sides of dry, rugged mountains or in isolated upland valleys. In temperament it profoundly differs from the horse. It wants the fire, courage, and keenness that make a horse, if urged, strive until completely exhausted. But given time it will accomplish more than a horse or any other beast of burden of a like weight and size. Though extremely intelligent, it is, as a rule, slow and stubborn; hence if 'he who drives fat oxen should himself be fat', he who drives the patient donkey should himself be patient.

In England no attempt has been made to form distinct breeds of asses, but several distinct types have been created on the Continent, and quite a number are met with in the East. Of European breeds the Spanish are perhaps the most famous, though not so familiar as the Poitou variety. The Poitou ass, probably derived from an ancient Spanish race, is characterized by a large head and enormous ears—ears lined with silken ringlets, but so ponderous that they are usually carried in a horizontal position, if not actually hanging down as in lop-eared rabbits. As the result of selection the Poitou breed is now distinguished by a heavy rough coat, large knees, plenty of 'bone'

---

[1] This is due to the fact that domestic horses include amongst their ancestors both long- and short-eared species.

—a 14-hands specimen often measures 8 in. below the knee—and by hoofs nearly as wide at the heels as in the zebra of Somaliland. In addition to Spanish and French breeds there is a large breed in Italy, a breed with fine clean legs in Malta (now best represented by a herd at Knockalva in Jamaica), and a very handsome variety in Pantellaria, a small island to the south-west of Sicily. Of Eastern breeds the most renowned is perhaps one—said to be of Arab lineage—met with in Syria, Persia, and Egypt. Tall, active, and docile, and of a distinctly riding type, the members of this variety are extensively used as mounts by sheikhs, priests, lawyers, and rich Eastern merchants. A smaller Eastern variety, built on similar lines, but with a still more agreeable gait, is generally reserved for the use of ladies. Of larger Syrian breeds, one, of a decidedly heavy build, is used for ploughing and other farm work, and also for conveying merchandise from the larger towns to the adjacent villages. Another, especially common in Damascus, characterized by a very long body, and ears as large as in the Poitou race of France, usually takes the place, in certain parts of the East, of the Percherons, Shire, and other draught horses of western Europe.

The part played by asses of the lighter type in an Eastern city is well described in the following passage from Mr. Wilson's account of a year spent in Persia:—'The donkeys are the sight *par excellence* of the streets of Tabriz. Donkeys with provision baskets filled with grapes or other fruit, with garden truck, or firewood; donkeys with butchered animals strapped on their backs; donkeys loaded with two mountains of straw larger than the beast itself; donkeys with all sorts of building materials, the bricks falling off, the poles dragging and ready to hit an unwary passer-by on the shins; white donkeys mounted by white-turbaned high priests of Islam or veiled Khanums of the harem; wee grey donkeys with the rider dangling his feet within a few inches of the ground; donkeys returning at double-quick time, their loads having been disposed of. Without halter or bridle they crowd on one another and over the sidewalks, leaving no room for the pedestrian.'

There is no kind of work to which the horse is put that cannot be more or less successfully performed by the ass. Martin, in his work on the history of the horse, refers to a donkey, fleet, docile, and intelligent, which had often 'been in at the death after a tolerably hard fox-chase', and, as already mentioned, asses were at one time used in war. The ass is, however, better adapted for slow, steady work than for either sport or war, or for taking part in tournaments or pageants. At the present day the larger varieties are especially useful for breeding mules, while the smaller varieties, being less costly, hardier, and less liable to disease, more easily fed, and longer lived than the most vigorous moorland ponies, are pre-eminently suitable for playing the part of the poor man's beast of burden. It is unnecessary to submit evidence of the vigour and frugality of the common donkey, but an instance may be given of its longevity. In Brettell's account of the Isle of Wight, it is mentioned that an ass for the space of fifty-two years drew up water daily from the deep well of Carisbrooke Castle. This animal was probably at least three years old when he began to work at the wheel, and had he not met his death by falling over the ramparts of the castle he might have continued to draw water daily until he was well over sixty, for when he accidentally met his death he was still 'in perfect health and strength'.

In asses the period of gestation seems, as in zebras, to vary from 360 to 375 days, it is hence nearly a month longer than in horses living under domestication. The milk of the ass contains more sugar, and is said to be more easily digested than cow's milk. In the East, from time immemorial herds of mares have been kept to provide milk—it is from mare's milk that the Mongol makes his koumiss—but in certain parts of Africa there are great herds of asses which the natives only use for milking. This is especially the case, according to Jephson, to the east of the Dinka country.

The foal of the ass has at birth, in cold areas, a thick coat of long hair of nearly the same colour as the parents. A foal I bred from 10-hands parents was, notwithstanding the long ears, a very attractive little creature. At birth it measured 26 in., but by the end of the second month it was 30 in., and when six months old it measured 33 in. at the withers. When a year and a half old it was 36 in. at the withers and 37½ in. at the croup.

In a wild state Sir Samuel Baker says the ass 'is the perfection of activity and courage, and has a high-bred tone in its deportment, a high-actioned step when it trots freely over rocks and sand, with the speed of a horse when it gallops over the boundless desert'. An indication of activity and courage one often notices in a well-fed donkey stallion, but activity and courage are quite as marked in a she-ass with a new-born foal. At first she shadows her foal exactly like a mountain zebra, and if a dog makes its appearance it is ruthlessly driven away. Foals of all kinds at first instinctively follow moving objects. When a horse foal follows a strange mare the mother rushes about in a state of despair, but a donkey, perhaps because of its greater intelligence, pushes her foal aside, or even with a thrust of the muzzle throws it to the ground, and thus prevents its straying. A Norwegian pony, when occasion demands, does not hesitate to join issue with a bear, in like manner a wild ass sometimes vigorously and successfully defends itself from its great enemy the lion. It is hence not wonderful that, when occasion demands, the dull and apparently unimpressionable donkey gives evidence of courage and agility.

In Britain the ass is employed in agricultural labour to a limited extent only. As the Kerry is justly to be regarded as the poor man's cow, so may the ass be considered as the draught animal *par excellence* for the cottager and small holder; and thus he is to be found chiefly in districts where small farms and crofts abound, viz. in parts of Wales, and more or less over the whole of Ireland. The eggs and butter which constitute the chief produce of the small farms of Ireland are brought to the market towns by this patient drudge. Indeed the spectacle of the farmer's wife driving along in her little donkey cart is frequently associated in the minds of tourists as an almost integral feature of the landscape of parts of the west of Ireland. In the hop grounds of Kent and in the market gardens around London the ass is equally at home, and performs useful labour in the marketing of vegetables and similar light labour. On account of his lightness of foot, also, he is peculiarly adapted for such operations as the mowing of lawns, and the borders of carriage drives and the terraces surrounding country mansions, hydropathics, &c., in which he is largely employed.

On the larger farms of England and Scotland his services are not much in demand, although the spectacle of a donkey drawing a turnip-seed drill is not unknown. So far as regards draught merely, there can be no doubt that the ass affords a cheaper source of labour than the horse; but being much slower in action, the use of the former involves a greater expenditure on human labour in order to effect a given amount of work, apart altogether from the fact that slow labour is incompatible with a comparatively cold climate such as that of Britain.

[J. C. E.]

Assessment, the determination of the value of property, made usually for purposes of taxation. See RATING.

Assimilation in Animals.—The vital activities of organisms, commonly termed their metabolism, are of two classes, constructive or assimilative, and destructive or dissimilative. The two processes go on simultaneously; their separate character is recognizable only in their results. Assimilation in animals, as in plants, is the transformation into living matter of substances which are not living, and of the building up of new non-living substances. It is to be distinguished from the process of absorption of the digested foodstuffs by the mucous membrane of the alimentary canal, which is a preparatory process for the transmission of these stuffs throughout the body for the purposes of assimilation. Animals utilize complex organic compounds built up in the first instance by plants. They are carbohydrates, fats, and proteids. Besides these, certain mineral compounds are made use of by animals in their assimilative processes. Calcium and magnesium are used for the skeletal framework, iron for the pigment of the blood; sodium and several other elements are also utilized. The energy liberated by animals is derived from the substances thus assimilated. As to the relative values of the raw materials, it may be stated that from fats and carbohydrates alone man derives about five times as much energy as he does from the proteids of his food. [J. R.]

Assimilation of Carbon Dioxide.—When a living plant is pulled up and dried in an oven at a temperature of 100° C. it rapidly loses water and dies. The dry body of the plant, or its 'dry matter' as it is termed, is found to contain from 40 to 50 per cent of its weight of the element carbon. A good crop of wheat will contain about a ton of carbon in its straw and grain per acre.

The slow accumulation of this element within the bodies of timber trees and growing plants generally has been a subject of interest from early times, and many investigations have been made to determine the source from which the carbon is derived. The view was prevalent up to the end of the 18th and beginning of the 19th centuries that the carbon was derived, along with other necessary food constituents, through the roots of the plant, from the humus or decaying vegetable matter of the soil. In the case of fungi and a few saprophytic flowering plants this is true; but Liebig in 1840, and Boussingault later, showed that green plants can grow satisfactorily and accumulate carbon compounds in their tissues when their roots are kept in sand or water containing no humus, so long as the leaves of the plants are exposed to the atmosphere. The only source of carbon available under these conditions is the carbon-dioxide gas of the air. Although the amount of this gas present in the atmosphere does not normally exceed more than about 3 parts in 10,000, it has been abundantly proved that this is the source from which green plants obtain all the carbon they need for their growth. Carbon-dioxide gas is being poured out continually into the surrounding air by all animals in the respiration process which they carry on. Moreover, all plants, green or otherwise, give off carbon dioxide. In the processes of fermentation and decay, and in the combustion of coal, wood, oil, and other fuels, a large amount of this gas is set free and diffuses into the atmosphere. Yet in spite of these additions the composition of the air in respect of carbon dioxide remains the same, since green plants continually absorb the latter and utilize the carbon in it for the manufacture of various substances needed in their nutrition and growth.

The absorption of carbon dioxide takes place through the stomata or minute pores of the leaves, and proceeds at an astonishing rate when circumstances are favourable. In one instance a sunflower absorbed 412 c. cm. of gas per hour for every square metre of leaf surface. Immediately after carbon dioxide enters a green leaf which is exposed to light, a similar amount of oxygen is usually given off into the air, and the plant rapidly increases in dry weight from the carbon, which is retained. It is found that the latter becomes combined with the element of water to form sugar and other carbohydrates. This process of the manufacture of carbohydrates by green plants from the carbon dioxide of the air is often spoken of as 'assimilation', although the same term is used by animal physiologists in a different sense. The facts may be represented in a general way thus:—

Carbon dioxide from the air + water from the soil < give in the plant to > a carbohydrate + oxygen.

The conditions governing the process will be discussed below. The chemical nature of the carbohydrate first produced has been the subject of much elaborate investigation. When the decomposition of carbon dioxide and the exhalation of oxygen from the green leaves of plants is going on, there is a rapid increase in the sugar-content of the leaves, and it would appear from the work of Brown and Morris that cane sugar is one of the early products of carbon-dioxide assimilation. A certain amount of these sugars are used in respiration, but the bulk are transferred from the leaf blades where they are made by way of the petioles to the stem of the plants, and finally to centres wherever the formation and growth of new organs is going on, or where reserve materials are being deposited.

In many plants starch grains make their appearance in the leaves as the first *visible* product of assimilation. But there is little doubt that these are made from the previously manufactured sugar, and that they only arise when the cells of the leaves are producing more carbohydrate material than can be used in cell nutrition, respiration, and translocation in the sap-stream going from the leaf to the stem.

At the end of the day the leaf tissues are loaded with starch, but during the night, when assimilation ceases, the starch is changed back again into sugars and other soluble substances by the action of the ferment diastase present in the leaf cells. Much of the starch or all of it disappears before dawn, and the dry weight of the leaf decreases, since the soluble materials are transferred to the stem and other parts of the plant. Starch in the leaf is merely a reserve material, just as it is in a tuber.

The various sugars which arise when assimilation is going on are highly complex chemical bodies, and it is highly improbable that they were formed directly from carbon dioxide and water. No doubt there are intermediate products simpler in constitution than the carbohydrates, but from which the latter are made; what these are is not certain.

Bayer in 1870 suggested that formaldehyde (CH_2O) is first produced according to the following equation:—$CO_2 + H_2O = CH_2O + O_2$, and that the sugars result from the condensation of this substance. This hypothesis, or some modification of it, is the most plausible hitherto advanced, and finds considerable support in the recent investigations of Pollacci and others.

The production of carbohydrates in the 'assimilation' process carried on by plants is dependent on a variety of conditions, of which the following are the most important:—

1. The plants must be living.
2. Carbon dioxide must be present in the surrounding atmosphere.
3. They must contain green chloroplastids.
4. Light of a certain intensity must be available, and
5. A suitable temperature is necessary.
6. The process is also influenced by the water supply and chemical nature of the materials taken up in solutions by the roots of the plants.

Assimilation ceases as soon as death of the plant takes place. The amount of carbon dioxide in the air is about 3 parts in 10,000. According to Brown and Escombe it varies from 2·7 up to 3·62 in 10,000 in the air, 3 to 4 ft. above the surface of the soil. On the surface and within the interstices of the soil the CO_2 may reach 12 parts per 10,000 or over.

Cailletet and Moll, however, have shown that the production of carbohydrates by the plants practically ceases, or is at any rate not sufficient for healthy nutrition, when the roots have access to soil or solutions containing CO_2, if the leaves are exposed to an atmosphere from which this gas is absent. The leaves are the chief organs in which assimilation of carbon dioxide is carried on, and the gas penetrates only through the stomata: direct proof of the latter fact has been given by Blackman and others.

It has been previously mentioned that oxygen is given off when CO_2 assimilation is going on. There is usually more oxygen exhaled than CO_2 absorbed. The ratio $\frac{CO_2}{O_2}$ varies in different plants: in cress it was found by Schloesing to be ·75, in mustard ·87, in flax ·9.

It is in the specialized portions of protoplasm, which are known as chloroplastids, that assimilation is effected in green leaves. These are small green structures embedded in the colourless protoplasm of the cells, the green colour being due to a peculiar substance, chlorophyll, with which they are permeated. In them starch grains generally make their appearance when carbon dioxide is being assimilated, and by utilizing certain aerobic bacteria it may be shown that oxygen is given off from the chloroplastids only, and not from the rest of the protoplasm, when assimilation occurs.

Chlorophyll may be extracted from the chloroplastids in a more or less altered form, but it has no power of reducing CO_2 in this state.

In the white parts of the leaves of variegated plants, in tubers and roots devoid of green colour, and in petals of coloured flowers, no assimilation of carbon dioxide takes place, although in such parts colourless plastids may occur which have the power of forming starch grains from sugars and other carbohydrates already formed in the green portions of the plant. The green-coloured plastids present have alone the power of manufacturing carbohydrates and starch from the simple inorganic materials CO_2 of the air and water from the soil.

Light has a potent influence on carbon-dioxide assimilation; without it chlorophyll is not formed. Moreover, it is from the rays of light that the energy necessary for the chemical changes involved in the process is derived. In darkness the manufacture of carbohydrates by green plants ceases, and in shady places, in crowded plantations, and on dull days in winter, assimilation is very much reduced. Starvation and improper nutrition occurs under such conditions. In most cases direct sunlight results in a maximum of work of this kind, but certain shade-loving plants need a moderate intensity of light for proper nutrition. The rays most active in the process are those lying between the yellow and red end of the spectrum. At low temperatures chlorophyll is not formed, and green leaves have little power of carbon-dioxide assimilation. As the temperature is raised, the latter increases up to about 20° or

25° C., after which it decreases until death takes place.

The assimilation of carbon dioxide in the absence of light, and without the aid of chlorophyll, is brought about by certain bacteria. The nitrite and nitrate bacteria concerned with the process of nitrification in the soil are able to utilize carbon dioxide as the source of the carbon needed for the formation of their organic substance. The necessary energy for the process is derived from the oxidation of nitrogenous compounds.

The sulphur bacteria are also capable of assimilating carbon dioxide, the energy needed being obtained from the oxidation of sulphur and sulphuretted hydrogen. [J. P.]

Aster.—A large genus of Compositæ scattered over Europe and Asia. Many of the species are cultivated as garden plants in this country, the smaller ones, chiefly from the Himalayas, in rock gardens, the larger, coarser species, chiefly from the United States, and popularly known as Michaelmas Daisies, being largely grown for autumn effect, most of them flowering late in the year when nearly everything else has been brought to an end by cold and wet. They are apt to become troublesome if planted in small borders, unless they are dug up annually and reduced in bulk. In large borders, mixed with shrubs, or in open plantations of trees where some sunshine can reach them, these Michaelmas Daisies are very effective. They thrive in the poorest soil, and supply most useful, elegant, pretty-coloured sprays at a time when flowers generally have become scarce. 'There is a quiet beauty about them, and their variety of colour, of form, and of bud and blossom is delightful. For the most part they are regardless of cold or rain. Less showy than the Chrysanthemum, they are more refined in colour and form. Even where not introduced into the flower garden, they should always be grown for cutting, and they are excellent for forming bold groups to cover the bare ground among newly-planted shrubs. Nothing can be more easy to cultivate. The essential point is to get the distinct kinds.' (W. Robinson.) The species hybridize freely, and a great number of improved garden forms have been obtained in consequence. They are easily propagated by division of the rootstocks in early spring, or from cuttings of the young shoots taken when they are 3 in. high and planted in sandy soil in a moist heated frame. The taller growers require to be supported with stakes, which should be as light as possible, willow or hazel wands being most suitable. The shoots may often be reduced in number with advantage. The best sorts are:—

Aster amellus bessarabicus

A. acris.—Early flowering, blue, 2 ft. high.

A. amellus, and its varieties *amelloides*, *bessarabicus*, and *major*.

A. cordifolius.—4 ft. high, graceful, flowers in plumes in October and November.

A. diffusus.—A delightful plant of spreading habit, about 1 ft. high, and covered with crimson and white flowers.

A. grandiflorus.—A yard high, flowers bright purple, developed in November.

A. Novæ Angliæ.—Tall, large-flowered, late. There are several varieties of it, named *pulchellus*, violet; *roseus*, pale rose; and *ruber*, bright crimson.

A. Novi Belgii.—The parent of some of the best of the tall elegant kinds, such as *Albion*, white; *Archer Hind*, rosy lilac; *Densus*, lilac purple; *Harpur Crewe*, white, rose-tinted; and *Robert Parker*, lilac purple, 2 in. across.

A. versicolor.—Dwarf and spreading, with white and pink flowers.

The China Aster is not an aster proper, but a Callistephus, which see. [W. W.]

Aster Parasitic Fungi.—Damping-off is very common, especially amongst seedlings; this indicates excess of moisture and lack of ventilation (cf. *seedling disease of cabbage*). The destruction of older plants, accompanied by mouldiness, is generally caused by the Aster Worm. See Enchytræus. [W. G. S.]

Asthenia.—A condition of asthenia, or want of vital power, of weakness or general debility without any defined or recognized disease, is met with in animals which are referred to as 'bad doers', 'wasters', 'skinters', and by other names. Such animals often prove later to be tuberculous, or suffering from organic disease, of which asthenia was but a symptom. Apart however from any known disease to be discovered by the most careful post-mortem examination, cases of asthenia do occur, and nothing is discoverable after death but such general pallor of the tissues as would necessarily result from the wasting which had been visible during life. It would seem as if some toxin inimical to the life of the red blood corpuscles gained access to the body, and caused their very gradual extinction. Investigations of an exhaustive character have been carried on by the United States Bureau of Agriculture in connection with asthenia or 'going light' in fowls. Although no specific organism or toxin has been so far isolated and identified as the cause, one is known to produce disruption of the blood cells in red water (see Red Water).

The persistent administration of iron and of vegetable bitter tonics is the most suitable treatment. [H. L.]

Asthma.—The difficult breathing recognized as asthma in man has no analogue in the animals of the farm, unless we include the dog as such. What is known as 'broken wind' in horses was formerly compared to asthma, but is now attributed to some nervous derangement connected with the digestive process. Fat and old dogs are the victims of asthma, which is dependent on an intermittent bronchial spasm. A spasmodic cough, accompanied with wheezing and ineffectual attempts to expectorate, are the chief symptoms. Treatment consists in keeping down the bulk of food, and giving only lean meat or other concentrated aliment. Sedative medicines, as chlorodyne, digitalis, belladonna, chloral, the bromides of ammonium and potassium, and opium, have marked beneficial effects in combination with expectorants such as ipecacuanha, sulphate of potash, antimonial wine, squills, and other remedies in common use for mankind. Owing to the dog's inability to expectorate, the bulk of the phlegm which he so laboriously coughs up is swallowed, and aggravates the trouble by an accumulation of viscid mucus in the stomach. For this reason emetics are found to give better results than other forms of medication. Apomorphine is the best of these for the dog, in doses of $\frac{1}{8}$ to $\frac{1}{2}$ gr. Sulphate of zinc, mustard, and the other substances in common use for man are effectual in exciting vomition in dogs. Many asthmatic old dogs may continue a career of usefulness by the administration of a suitable emetic about three times in a fortnight. It should be given on an empty stomach. Modern canine surgeons resort to the stomach pump, reversing its action in order to wash out the stomach, an operation which is followed by very great benefit. [H. L.]

Atavism.—When two varieties or two pure breeds are crossed, the offspring sometimes exactly resemble one of the parents, sometimes they are an unequal blend of both parents. Whether the crosses (now often called hybrids) are identical or nearly identical with either the male or the female parent, or are an unequal blend of both parents, they often when interbred produce offspring of three different kinds, viz.: (1) Some having the characters of the variety or breed used as the sire; (2) some having the characters of the variety or breed used as the dam; and (3) some resembling their parents, *i.e.* the first crosses or hybrids. In other words, some of the offspring throw back or revert to the grandsire, others revert to the granddam, while others take after their immediate ancestors or parents. In a crossing experiment of this kind we have an example of the simplest form of reversion or atavism.

When the crossing of two varieties or breeds, or of two species which yield fertile offspring, is made on a large scale with either plants or animals, it is ascertained that the reversion to the grandparents always takes place in a constant and orderly manner. For example, if the hybrids obtained by crossing two pure breeds of fowls or rabbits are sorted, it is found that 25 per cent have reverted to, and are, or appear to be, as pure as, the grandsire, that 25 per cent agree with the granddam, while 50 per cent resemble, and, when interbred, behave exactly like their parents, *i.e.* they again produce 25 per cent of each of the original varieties used, and 50 per cent like themselves. This law of reversion (discovered by Gregor Mendel when experimenting with peas) is now known as Mendel's law.

While the majority of reversions probably conform to Mendel's law, there are others which cannot be regarded as Mendelian. For example, when two varieties of pigeons (say an 'Archangel' and an 'Owl') are crossed, and their hybrids bred with a third variety (say a white Fantail), the offspring may in colour, make, and attitude very closely agree with the remote common ancestor of all the domestic pigeons, viz. the wild rock pigeon (*Columba livia*). But while an extreme case of reversion of this kind may not be Mendelian, it may be due to the same cause as the reversion which results when the offspring of two pure varieties or strains are interbred, *i.e.* the explanation which accounts for the orderly Mendelian reversion may also account for extreme forms of reversion, such as now and again occur in both plants and animals.

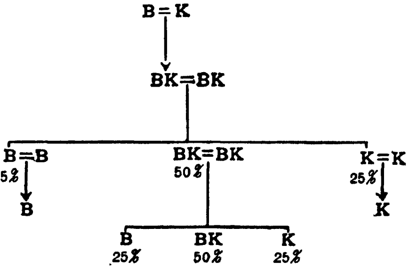


Fig. 1.—Diagram Illustrating Mendel's Law

B, Black-faced sheep crossed with K, St. Kilda ram, produced the crosses of hybrids B K. The hybrids B K when interbred produced (1) B—pure black-faced sheep; (2) K—pure St. Kilda sheep; (3) B K—hybrids, which when interbred again produced B, K, and B K.

How is Mendelian reversion explained? To answer this question reference must be made to the germ cells. In the case of animals developed from a single germ cell (from a parthenogenetic ovum, *i.e.* a female germ cell capable of producing a new individual without any assistance from a spermatozoon or male germ cell), there is very little if any variation of either a progressive or regressive kind. In the same way there is, as a rule, extremely little evidence of variation when the male and female germ cells are produced by closely related members of a long-established inbred race. This is probably because the male and female germ cells, being practically 'chips of the same block'—having great affinity for each other,—completely blend, when they eventually meet, to form what is technically termed the zygote or fertilized ovum. On the other hand, when two germ cells from unrelated individuals, belonging to distinct races or breeds, which for countless generations have been living under different conditions and developing in different directions, come into contact, there may only be just sufficient affinity to admit of their co-operating with each other to produce a new individual; *i.e.* the male germ cell may merely set up the subtle changes which eventually lead to the formation of a new individual, without, in a real and full sense, blending with the female germ cell—in very much the same way as certain chemical solutions start the development of the unfertilized eggs of sea-urchins and certain other invertebrates. This view is supported by what actually happens in some cases during and after fertilization; for, as we now know, there is in some cases an absence of that complete fusion one naturally expects during conjugation between the protoplasm of the male and female germ cells. Hence in the case of germ cells from distinct varieties, races, or breeds, there may be co-operation rather than blending, with the result that though the cells forming the somatic portion or body of the new individual may afford little evidence of incomplete fusion, the minute protoplasmic particles composing the cells destined to form the eggs or sperms may be, as it were, divided into two camps ready to take up independent positions whenever an opportunity offers. Such an opportunity occurs for a divorce taking place between the imperfectly blended germ plasm, derived from two very different sources, when the time arrives for the formation of the germ cells—for the appearance when maturity is reached of ripe sperms in the male and ripe eggs in the female. In a word, the offspring of hybrids consist of 25 per cent of each of the varieties or breeds represented by their grandparents, and of 50 per cent having the characters of their parents, because the germ cells of the hybrids, instead of being hybrids like their parents, are identical with, as pure as, the germ cells of their grandparents, 50 per cent of the ova and sperms consisting of protoplasm derived from each of the varieties or breeds originally crossed. If 50 per cent of the offspring of hybrids are atavistic —25 per cent reverting to the granddam and 25 per cent to the grandsire—because the hybrids produce pure germ cells, it is highly probable that reversions to remote ancestors may in at least some cases be due to the appearance of germ cells identical or nearly identical with the germ cells of more or less remote ancestors.

Perhaps, however, the resemblance between germ cells may in many cases be physiological rather than morphological. In many cases the one germ cell is so prepotent that the other seems to count for nothing in the new individual produced. When this is the case the parent which supplied the prepotent germ cell is termed the *dominant* parent, the other the *recessive* parent. When there is reversion to a remote ancestor it may not be due to germ cells being in structure an exact reproduction of those of the ancestor restored, but rather to the ancestral germ plasm for some reason or other proving more prepotent than the germ plasm of the more immediate ancestors—to the ancestral germ plasm proving dominant. Traits recently acquired are often easily lost. When members of two varieties fundamentally alike but differing in minute details are crossed, the recently acquired points are often feebly developed or altogether absent from the offspring. In some cases this is doubtless in part due to the points of the one variety being very different if not actually antagonistic to the points of the other variety. When in various respects the one variety, instead of affording support, is actually antagonistic to the other, ancestral characters, having a clear field, are almost certain to surge to the surface.

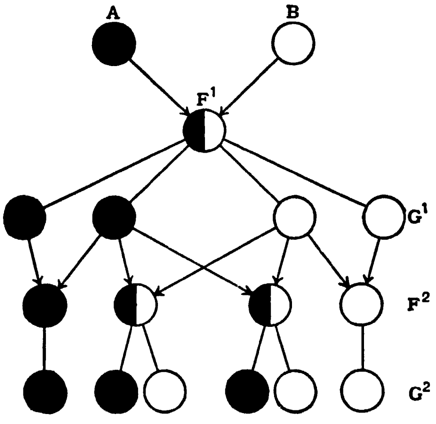


Fig. 2.—Diagram indicating how the Pure Germ Cells produced by Hybrids may combine to produce Pure and Hybrid Offspring

A and B, two pure varieties. F^1, hybrid offspring. G^1, pure germ cells produced by hybrids. F^2, pure and hybrid offspring—25 per cent like variety A, 25 per cent like variety B, and 50 per cent hybrids. G^2, pure germ cells produced by the second generation. (After Prof. Arthur Thomson.)

It may hence be assumed that pronounced reversions that lie beyond the pale of the Mendelian hypothesis may in some cases be due to the accidental appearance of germ cells nearly identical in composition with the germ cells of long-lost ancestors, while in other cases they may be due to the ancestral protoplasm gaining ascendancy over the protoplasm representing recently acquired and not yet well fixed characters.

Amongst wild plants and animals there seems to be a constant struggle between progressive and regressive variation, the progress made in any given direction being as a rule to a certain extent lost or toned down by reversion. In Galton's law we have an attempt to account for reversion. This law teaches that the parents contribute one-half, the grandparents one-quarter, the great grandparents one-eighth, and the more remote parents the remainder of the characters to the average offspring. When, however, the progress is rapid or discontinuous, *i.e.* when sporting takes place, the regression may be decidedly less than Galton's law leads one to expect. But in all cases breeders must be prepared for a certain amount of reversion even when working with pure more or less inbred strains, and they should ever bear in mind that if an objectional trait of any kind, mental or physical, is introduced into a strain, many generations may elapse before it is again got rid of. The breeder's great objection to retrogression is that extremely desirable characteristics—whether they arise fortuitously or are the result of a series of carefully thought-out matings—are liable to be altogether lost, or so dwindled by reversion that they do little to enhance the value of the breed. Apparently new points are sometimes lost through want of vigour in the breeding stock. When this is the case, reversion is more likely to be checked by using a vigorous sire in which the desirable trait is feebly developed, than a closely related but non-vigorous sire with the features or points it is wished to perpetuate unusually well developed. In nature, reversion may in some cases be highly beneficial by toning down extreme variation, which if left unchecked would produce varieties ill adapted for the environment. In the case of domestic animals it is useful in as far as it now and again gives the breeder the opportunity of restoring the lost vigour of his special strain without resorting to intercrossing, *i.e.* to the infusion of new blood. Amongst wild animals inbreeding seems to be harmless because the unfit are mercilessly eliminated. But amongst domestic animals inbreeding may in some cases soon lead to a loss of vigour if not also of size and fertility. Whether or not this happens largely depends on the breeder. If from time to time advantage is taken of fortuitous reversions the vitality of even closely inbred strains may be long maintained at a high level. In 1899 an inbreeding experiment was started with a pair of goats which were neither inbred nor intimately related. Though no fresh blood has been introduced, the kids born in the spring of 1907 are, notwithstanding very close in-and-inbreeding, larger and more vigorous than those born in 1898. This result has been partly due to the fact that nothing has ever been done to prolong the life of weaklings, but chiefly because in the 1905 kids there was almost complete reversion to the vigorous sire used when in 1899 the experiment was initiated.

Only one other advantage of reversion need be mentioned. In the case of domestic as in the case of wild animals, natural selection is constantly at work, even when the conditions provided by the breeder are, or seem to be, of the most favourable description. In other words, the surroundings, however favourable, are constantly at work eliminating the individuals ill-adapted for their immediate environment. Sometimes the season is too dry, sometimes too cold and damp, sometimes it favours the appearance of dangerous parasites. If in any given herd there has been reversion in several directions, the chances are that there will always be some individuals capable of coping with the unusual drought, the cold moist conditions, or the excessive number of external or internal parasites. The following examples will serve to illustrate the kind and nature of the reversions likely to come under the notice of breeders. Many examples might be given of reversion in plants, but it will suffice to give instances from the animal kingdom.

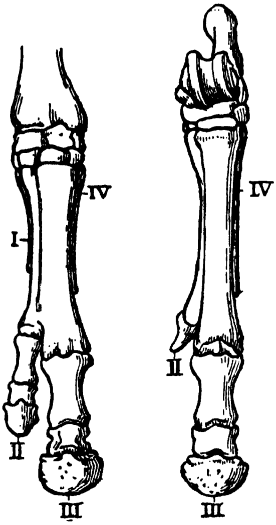


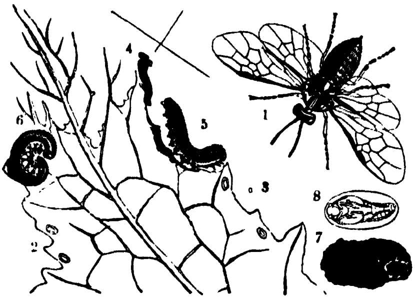
Fig. 3.—Examples of Atavism in the fore limb of the horse

It is hardly necessary to say that it is sometimes difficult to distinguish regressive from progressive variations, that it is conceivable an organism may hit 'an old mark when trying to hit a new one', and that only the appearance of characteristics which existed in the more remote ancestors can be included in the category of reversions. By studying the development of the Equidæ it was discovered some years ago that the horse passes through a three-toed stage, thus confirming the view that the living members of the horse family have sprung from three-toed forms which flourished during the Miocene period in America if not also in Asia. By artificial selection the third or middle toe has been so greatly increased in Shires and Clydesdales that it is now nearly twice the size it reached in their Pleistocene ancestors. The constant selection of individuals with a large middle toe has apparently led to changes in the small degraded second and fourth toes—in the 'buttons' which form the tips of the splint bones—but now and again one or both of these toes increase sufficiently to project through the skin and form an 'extra' digit (fig. 3, II and II). When this happens we have an excellent and very remarkable example of reversion or atavism—the unexpected restoration of a complex structure which even in Miocene times was as useless as the pettitoes of our present deer and oxen.

Recent investigations indicate that the majority of the horses now living under domestication have in part sprung from a species akin to the wild horse (*Equus prejevalskii*) which still survives in Central Asia. In this wild horse the mane is short and upright, the forelock absent, and the tail mule-like—the upper part of the dock carries short hairs of a greyish colour, the middle part longer and somewhat darker hair, while from the tip grows a small bunch of strong black hair which ends in a point about the level of the fetlocks. Probably twenty thousand years have elapsed since the horses of the Prejevalsky type were blended with certain other types to form the foundation stock from which the domestic horses of north-western Europe have sprung. Nevertheless one occasionally comes across domestic horses both in Europe and America in which the mane and tail remind one forcibly of the wild horse recently discovered in Mongolia. By crossing a primeval-looking mouse-dun Shetland pony mare with a black Welsh pony stallion what might very well be called a hybrid has been produced; for there is only a short tuft representing the forelock, the mane is so short and stiff that instead of lying in contact with the neck it is semi-erect and arches to both sides of the neck, while the tail in colour, structure, and amount very closely agrees with the tail of a wild mare recently imported from Mongolia. Had the history of this cross and her parents not been known, the somewhat mule-like mane and tail might very well have been regarded as a striking instance of telegony—been accounted for by assuming that she had been infected by a previous sire to which she had produced mules. Now that we are satisfied domestic horses include amongst their ancestors a species like Prejevalsky's horse, we realize that in the mule-like mane and tail of this cross-bred pony we have an undoubted instance of reversion. One other instance of reversion in the Equidæ may be cited. It has long been assumed that the Equidæ have descended from a 'dun-coloured ancestor more or less striped'. For reasons already hinted at, crossing often leads to reversion—the amount of regression varying as a rule with the amount of the difference between the varieties or species experimented with. When, *e.g.*, a white-limbed true Burchell zebra is crossed with a zebra of the Chapman variety having only faint bars above the knees, the hybrid is generally richly barred to the hoofs. Again, when an ass and a mare both devoid of leg stripes are crossed, a mule with distinct bars on the legs is often obtained. In these cases the reversion, though sufficiently evident, is not very pronounced. When, however, a Burchell zebra is crossed with a mare or with an ass, the hybrids obtained have sometimes quite twice as many stripes on the face, neck, and trunk as the zebra parent—as many stripes as in the very richly decorated Grey's zebra of Abyssinia and Somaliland. One can only account for the great increase in the number of stripes in certain zebra hybrids by assuming there has been reversion to a remote ancestor of the Burchell zebra, which in its markings resembled the species still living in Somaliland. In Mr. Darwin's Animals and Plants under Domestication; in my papers on Reversion and Telegony (Transactions of the Highland and Agricultural Society, 1901-2); the Penycuik Experiments (A. & C. Black, 1899), and in all works on heredity and variation, many cases of reversion are given. Moreover, every breeder is more familiar with regressive than with progressive variation. When the numerous cases recorded are considered it becomes evident that reversion may be limited to one or two unimportant traits—a patch of colour, a peculiar attitude or expression—or be so complete that it may result in the all but complete restoration of a remote ancestor. See also arts. BREEDING, LAWS OF; MENDELISM; TELEGONY.

[J. C. E.]

Athalia spinarum (Turnip Sawfly, or Tenthredo) is a handsome insect, which sometimes is found as early as May, but it is most abundant from the middle of August to October. The female (see 1 in fig.), by means of four little saws inserted under her tail, cuts through the lower skin of the leaf close to the edge, and deposits her eggs (see 2 in fig.); they are minute (see 3 in fig.), but quite visible, from their being enveloped in little oval sacs, which are pellucid, or of an ochreous tint. In five days these hatch, and the caterpillars commence feeding upon the turnip leaves, leaving only the fibres; and often rendering the field a forest of skeletons, to the destruction of the bulb. It is a very remarkable fact that in some situations they will not touch the swedes, whilst in other places they reject the white turnip leaves; and again they will be seen stripping a field in the most regular succession, or taking it off by large patches; this, however, arises from the deposition of the eggs; the charlock also is not an unacceptable food to them. The caterpillars are called Black Palmers or Niggers. They are so



The Turnip Sawfly (*Athalia spinarum*)

1, Female, magnified (natural size shown by cross lines); 2, leaf as cut for deposit of eggs; 3, egg; 4, leaf as eaten by caterpillar, with left skin; 5, caterpillar feeding; 6, same at rest; 7, cocoon; 8, pupa.

voracious that in two days five of them ate off two young swedes, the leaves being 1½ in. long. They often change their skins, which are left sticking to the leaves and fibres, as 4 in fig., which also shows the extremity of the leaf and the fibres as left by them. They grow until they are ¾ in. long, but decrease in size at the last moult, and change their appearance, becoming of a slate colour and shining, being previously of a deep lampblack, with a darker line down the back, and a pale slate-coloured line down each side, passing over the breathing pores; in others, the whole belly is of the same tint. They generally feed in a singular attitude, with their tails raised (see 5 in fig.); they rest stretched out at full length, or lie curled up when disturbed (see 6 in fig.). The head is horny and shining; the whole body finely wrinkled; they have six sharp pectoral feet, and sixteen fleshy, two of them being at the tail. When full grown they bury themselves, and construct an earthen cocoon of the closest texture, brown outside and silvery inside (see 7 in fig.); within this the caterpillar spins a transparent oval cocoon, and changes to a pupa (see 8 in fig.); in this state the summer broods remain three weeks, but the autumn ones lie buried until the spring before they hatch, when the fly cuts a round lid in the cocoon, forces its way through the earthen cell, and makes its appearance above ground.

The male flies (see Plate, INSECTS—I, fig. 7*a*) are smaller than the females, but they are similar in colour: the head is black, mouth ochreous, eyes prominent, with two short horns, whitish at the base in the male; the trunk is brick-red, with two large black spots, and several smaller ones on the back; the body is bright orange, valves of the oviduct black; the under side is entirely ochreous or orange, and the six legs are of the same colour, spotted with black; the tips of the shanks and of each joint in all the feet being black, as well as the claws.

The visits of these sawflies are very inconstant; sometimes they do not make their appearance, at least in sufficient numbers to attract notice, for very long periods; at others, they are troublesome for two or three years successively. It has been asserted that they migrate from the Continent, which seems far from improbable, from observations made on the coast; and their sudden and irregular visits support this opinion. They are greatly influenced by temperature, winds, and other atmospheric changes. An ichneumon fly, named *Bassus athaliæperda*, is the only parasite observed to infest the black caterpillars, and that to a very small amount. [J. C.]

Athous hæmorrhoidalis (Red-tailed Click-beetle) is a species so abundant in cornfields, from April to July, that its wireworm no doubt is very destructive, and it is supposed to resemble those of *Agriotes lineatus* and *A. obscurus*, except that it is larger. The beetle is downy, with short ochreous hairs; the head and trunk are black, and very thickly punctured; the wingcases are hazel-brown, with eighteen punctured furrows; the wings beneath are ample, and it is often seen flying; the legs and underside are reddish-brown, the trunk and breast darker, often blackish; it is 6 lines long.

A. longicollis (Long-necked Click-beetle) is often found in cornfields in spring and summer, and is produced from a wireworm; but whether it is injurious to corn crops has not been discovered. The male is narrow, of a fulvous colour; the head and trunk are black and punctured; the latter is longish, with the margins rusty; the scutel and breast are blackish; the wingcases have eighteen lines of dots, and the outer margin is brown; beneath them is an ample pair of wings; length, 4¼ lines. The female is broader, larger, and varies in colour from a uniform brown to an ochreous tint.

A. niger (Black Click-beetle) is polished black, clothed with shining yellow hairs. It is elliptical, finely and not thickly punctured; there are eighteen fine furrows drawn down the back of the wingcases, which cover wings for flight; length, ½ in. It is very abundant in May and June in cornfields, meadows, and hedges; the wireworm is said to live in very rotten horse-muck. See also WIREWORM. [J. C.]
[F. V. T.]

Atmosphere is generally taken to mean the invisible gaseous envelope surrounding the earth, and more commonly called the air. Besides the earth other planetary bodies are known to possess atmospheres, but as yet no exact knowledge of their nature is obtainable. The thickness of the aerial envelope surrounding the earth is not accurately known, but investigation shows that it undoubtedly extends to a distance of at least 45 miles from the earth's surface. The atmosphere possesses weight and can therefore exert pressure. The average weight of air at sea level throughout the British Isles is found to be equal to a pressure of 14·73 lb. per square inch, or equivalent to the weight of a column of mercury 29·905 in. or 760 mm. (metric system) high. The pressure is measured by a barometer (see BAROMETER). Air is elastic and compressible. The lowest strata of air, in addition to their own weight, support the weight of those above, and hence become condensed and compressed. As the height from sea level increases, the density therefore decreases. For this reason the pressure of the air at the top of a high mountain is less than at the base. The pressure of the atmosphere diminishes progressively with increase in altitude from sea level, hence it is possible to calculate the height of a given altitude from the decrease in pressure recorded. Well-defined differences in atmospheric pressure exist according to the time of year and relative position on the earth's surface. The pressure is never constant at a given place for any length of time and generally varies from day to day. This arises from several causes. In the first place, by variation in temperature. As the atmosphere becomes heated it expands in volume, and diminishes in density; the weight, therefore, of a given volume of air at a low temperature is heavier than the same volume of air at a higher temperature. From this it follows that large masses of cold air are denser than warm air. In the second place, it is affected by the amount of water vapour present. Water vapour weighs less than air, volume for volume. Any increase in its amount in the atmosphere is therefore followed by a diminution of pressure.

When the density of air remains uniform there is perfect stillness, but the slightest variation in this upsets the equilibrium of the atmosphere, and in consequence currents of air are set up by the movement of masses of denser air towards those of lighter air, which latter are partly or entirely displaced by the former. These currents or movements of air are called winds. The theory of winds is perhaps best illustrated by land and sea breezes. On the coast in calm weather a breeze sets in from the sea to the land in the morning, changing its direction from land to sea after sunset. The sun's heat passes through air without appreciably heating it; the warmth of the air comes mostly by radiation of heat from and by contact with the land. The sun in the morning heats the land more quickly than it does the sea, and in consequence of this air resting on the land becomes warmer and lighter than that resting on the sea; the latter therefore flows towards and displaces the former. After sunset the conditions are changed, for the land by radiation cools quicker than the sea and the air becomes denser on the land than on the sea; currents are therefore set in motion in a contrary direction to that of the day.

In a similar way trade winds are caused by the unequal heating of land over large tracts of the earth. The direction and force of winds are, however, modified and regulated by many other factors, for further particulars of which the reader must consult the article on the weather. The atmosphere gets its warmth mainly: (1) directly from the heat rays of the sun; (2) by radiation of heat from or by contact with the warm earth.

Air is practically a mixture of oxygen and nitrogen. It also contains in small amounts carbon dioxide, aqueous vapour, minute quantities of ammonia, nitric and nitrous acids, ozone, sulphur dioxide, hydrogen, hydrogen peroxide, argon, helium, neon, crypton, &c., hydrocarbons, also some dust, and bacteria.

The proportion of oxygen and nitrogen present is:

	By Weight.	By Volume.
Oxygen	23·0	20·96
Nitrogen	77·0	79·04
	100·0	100·00

Owing to the frequent and continual movements of the atmosphere a thorough mixing of its components takes place; for this reason no wide differences in its composition are ever found. Some well-defined variations, however, exist in the proportion of carbon dioxide, ammonia, nitric acid, &c., according to local circumstances, which will be referred to again when these gases are under consideration.

The relationship of the air to plant and animal life is too well known to need emphasis here. Besides being indispensable to most forms of life, it has been one of the main factors in the disintegration and decay of the crust of the earth, in the formation of soils, and in innumerable other chemical and biological changes in operation in the ordinary course of nature. Many solar phenomena are accounted for by the existence of the earth's atmosphere.

Oxygen is perhaps its most important constituent. When substances burn in air it is due to their combination with this element. During the slow combustion of food substances dissolved in the blood the heat thus generated forms the source of warmth to the body. It plays a part of vital importance in animal and vegetable growth.

Nitrogen, as shown above, forms the largest constituent, but unlike oxygen does not support combustion. In combination with oxygen nitrogen exists in minute quantities as nitrous and nitric acid, and combined with hydrogen it is present in small amounts as ammonia. It is an essential constituent of the food of plants and animals. Some plants, namely those belonging to the order Leguminosæ and some of the lower forms of plant life, can assimilate it in the free state (see NITROGEN FIXATION BY PLANTS), but the majority of plants can only make use of it as a food when in combination with other elements, that is when in a combined form. Animals likewise cannot make use of free nitrogen, but they depend upon their supply from the compounds of nitrogen manufactured by and stored up in plants. Nitrogen, unlike oxygen, is a very inert gas and does not readily combine with other elements. However, during electrical discharges through the atmosphere, at the high temperature of the electric current, combination of oxygen and nitrogen under such conditions takes place, forming an oxide of nitrogen which dissolves in the water vapour with production of nitric and nitrous acid. These acids are brought down by rain. The quantity collected at Rothamsted from the average of a number of years amounted to 1·1 lb. per acre per annum. Generally there is a little more in rainwater over towns than in the country. Ammonia present in the atmosphere originates from the decomposition of nitrogenous compounds of vegetable and animal origin. The quantity brought down by rainwater at Rothamsted per acre per annum amounted on an average to 2·6 lb. From the same observations the total amount of combined nitrogen brought down by rain per acre per annum amounted to 4·7 lb., including the organic nitrogen. The combined nitrogen in the atmosphere varies in amount according to season and locality; generally there is more in air over thickly populated districts. This supply forms a valuable yearly increment to the stock of nitrogenous food for crops.

Water vapour is the most variable constituent of the atmosphere. The amount present is regulated principally by the temperature. As the temperature increases there is a corresponding increase in the power of the atmosphere to take up water vapour. There is, however, a limit to this power. For a given temperature a definite weight only can be absorbed; when that point is reached the atmosphere is said to be saturated with water vapour at that temperature. Should that temperature be lowered a deposition of water vapour goes on until the saturation-point is reached again for the lower temperature. The form of deposition, whether as dew, rain, hail, or snow, is determined by local or other conditions.

The degree of humidity is the term generally applied to the degree of saturation, and the temperature at which the atmosphere begins to deposit moisture is called the dew-point. The rainfall throughout the British Isles is very variable; it is greater on the west than the east coast, and it is the highest in January and lowest in June as a rule. For further information the reader must consult the article on RAINFALL.

The presence of carbonic acid gas and its connection with the supply of carbon to all green-coloured plants has been long known. The proportion present is liable to considerable variation, though not through such a wide range as water vapour. The processes of respiration, combustion, fermentation, and decay are attended by the evolution of this gas, hence more carbonic acid gas is found in the atmosphere of inhabited places than in the open. The quantities present are approximately as follows:—

In the country ..	·034 per cent
In towns ..	·05 ,,
Over the sea ..	·03 ,,

In the country there is generally more at night than in the daytime. When breathed in the pure state it causes death through suffocation, hence its accumulation from respiration in dwelling rooms is injurious to health, and shows the need of thorough ventilation. With crops in active growth its presence in the atmosphere is of vital importance. Warington states that an acre of good wheat will in four months obtain from the atmosphere one ton of carbon; for this to take place a thorough circulation of air around each plant is necessary. During the assimilation of carbon by plants from carbonic acid gas, the oxygen with which it is combined is given back to the atmosphere. This mutual interchange of elements seems part of an established law by which the workings of nature are kept in continual and perpetual motion.

[R. A. B.]

Atomaria linearis (Pygmy Mangold Beetle).—A small beetle which is often very harmful to mangolds by destroying the sprouts of the mangold seeds just as they germinate; then as the plants grow they attack both leaves and roots. The damage below ground consists, besides destruction of the sprout, in the eating of the taproot in places, which turn black. The crop is often entirely ruined. The leaves are eaten in holes. The small brown beetle ($\frac{1}{12}$ to [illegible]). The are very active, and are found above and below ground; their small size and colour make them difficult to see, and they have been taken to be ants. They leave the roots, it seems, in July, and have been found amongst grasses. The eggs are laid on the ground and the pale larvæ live in the soil.

Treatment consists in rolling and dusting with soot.

[F. V. T.]

Atriplex (Orache).—Among the various annual weeds of the Mangel family to which the name of *Fat-hen* is given (apparently because the seeds are nutritious and much sought after by poultry) are certain species of the genus Atriplex. These species are distinguished from other weeds of the same order, such as goose-foots (Chenopodium), by their flowers being of two kinds, male and female, and by the female flowers having a calyx of but two broad compressed sepals, which, persisting round the fruit, appear like a minute green bivalve shell. One of the commonest species is that figured, the Spreading Orache (*Atriplex patula*), which inhabits dunghills, rubbish heaps, and all sorts of waste places. It is a prostrate annual, with a dull-green or grey aspect, owing, in part, to meal-like hairs formed over its surface. From the presence of these meal-like hairs these weeds are sometimes called mealed weeds or *meld-weeds*. The leaves are alternate and halberd-shaped, but near the top of the stem they lose their angular condition altogether, and become rounded off at the base. The flowers are small, dull green, growing in small interrupted tufts, on both terminal and axillary branchlets. The plant flowers in June, continuing to do so till the end of August or later, and all the time is forming its seeds. These are

Orache (*Atriplex patula*)

small, dark-brown, finely wrinkled, and covered by a mere pellicle of ripened pericarp.

The Spreading Orache, like all annual weeds, is extirpated without difficulty by merely preventing the plants from flowering, or by hand-pulling when young. The seeds of these plants will lie in the ground for centuries without perishing.

In the gardens is sometimes yet cultivated the *Atriplex hortensis* (garden orache), an old-fashioned spinach, some of whose varieties have green, and others dark-purple, leaves.

[J. L.]
[A. N. M'A.]

Atropa, the botanical name of Belladonna or Deadly Nightshade. See BELLADONNA.

Atropos divinatoria (Book Louse).—This small indoor pest will attack anything edible—books, papers, stores, saddlery, &c. It is a small semi-transparent insect about 1/20 in. long, quite wingless, with two long thin antennæ. It belongs to the so-called Psocidæ, a family of Neuroptera. Movement is very rapid, the insect always running to shelter and darkness. It is most abundant and destructive in summer. By means of their strong jaws they do much damage to books, papers, &c., and are often very destructive to flour and meal.

Frequent cleaning and airing of articles is all that is necessary to stop its inroads.

[F. V. T.]

Attagenus pellio (the Fur Beetle).—A small beetle which is a great destroyer of furs, saddlery, and household goods. It is ⅕ in. long, black, with a small bright white spot near the centre of each wingcase and three on the hind edge of the thorax, and traces of a smaller one on each wingcase near the base. The spots are composed of hairs, and these rub off. The larvæ are quaint objects clothed with long reddish-brown hairs, giving them a silky appearance, and have a very long brush of hairs at the tail. The attacked goods can only be cleaned by being baked or fumigated.

[F. V. T.]

Attelabus curculionoides (Oak and Chestnut Box Beetle).—A local but common weevil which cuts the leaves of oak and sweet chestnut and rolls them up into short cylindrical boxes, in each of which the female places an egg, and in which the larva lives. The beetle is from ⅙ to ¼ in. long, with shiny brick-red thorax and elytra, black beneath, proboscis curved. They chiefly occur in underwood, and do some harm in nurseries, especially in the Midland counties and Kent and Sussex.

The 'boxes' should be collected in nurseries by hand and destroyed. [F. V. T.]

Aubergine (*Solanum Melongena*).—The Egg Plant, Brinjal, is an annual which is cultivated for its fruits (or aubergines), which are highly esteemed in many countries, although they have not yet found much favour in the British Islands. Here the plants are used as decorative plants, especially a variety called *ovigerum*, which has fruits very like hens' eggs in size, shape, and colour. The fruits are eaten either raw or cooked, in the same way as tomatoes. There are many varieties, their colour ranging from white to black-purple, and their size up to 8 in. in length and 3 in. in diameter. The seeds are sown in heat in January or later, and the plants grown under glass until May, when they are planted in the open ground. The aubergine might well be grown and utilized in this country as the tomato has been.

[W. W.]

Aubrac Cattle.—A French breed of cattle of a type specially adapted for grazing on rough and exposed upland pastures, resembling in this respect the West Highlanders, Galloways, &c., of this country. The granitic plateau of Aubrac, with the surrounding districts of Aveyron, Lozère, Saint Flour, and Cantal, forms an immense grazing ground wherein these cattle roam about in summer. It has been estimated that they number over 30,000. Their characteristics closely resemble the corresponding type in this country—short in the legs and deep in body, with broad chest and well-sprung ribs; medium-sized head, with strong, thick muzzle; horns also of medium size, well set, and curving upwards and backwards; soft elastic skin, with a velvety covering of hair. The colour is not uniform, being of various shades and mixtures of black, red, grey, roan, &c. The cows are poor milkers, 2 gallons per day being exceptional even in the period of full flow. The calves are early weaned, and the milk used for the production of a special local variety of cheese. The bullocks are grazed and fattened for the butchery trade of Lyons chiefly. The ox has long been used for draught purposes.

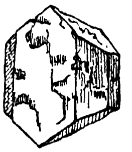
[J. B.]

Auction.—Auction is a public sale to the party offering the highest price, where the buyers bid against each other; or to the bidder who first accepts the terms offered by the vendor, where he sells by reducing his terms until someone accepts them. The latter form is known as a Dutch auction. For the law relating to sales by auction, see under SALE. See also next art.

Auction Marts.—Sales of live stock on special occasions, such as a change of tenancy, or when an owner wished to dispose of surplus animals or the whole of them belonging to him, have been held in this country for a very lengthened period. Auction marts at which sales were held periodically at more or less frequent intervals were started during the third quarter of the 19th century, and they increased very much in number during the closing quarter of that century. They are now very numerous, and a large proportion of the live stock in Great Britain is sold in these marts. To a large extent they have supplanted fairs and markets, at which, in former times, cattle and sheep were wont to be exposed for sale by private bargain. Both fat and lean stock are disposed of by auction. Most auction marts are furnished with weighbridges, but only to a very limited extent are the animals actually sold according to live weight. A large proportion of fat cattle are passed over the weighbridges in such a way that intending buyers can see their live weight, but the practice of the buyers bidding so much per cwt., or any other standard of weight, is very limited. However, those bidding for the beasts have an opportunity of judging of their value not only by the eye, but also by their gross weight on the scales. The butchers and dealers have not supported or encouraged the system of selling by live weight. These classes are experienced expert judges without the aid of the weighbridge, and consequently they have the advantage of the farmers and other sellers, who, besides passing comparatively few cattle through their hands, have no opportunity of checking their judgment formed by the eye by ascertaining the actual carcass weight of the animals after they are slaughtered. The principal advantage to the sellers of selling at auction marts is that they can dispose of their stock at any time when they wish to do so, at a minimum of trouble and for cash. It is alleged that one of the disadvantages is that farmers are not likely to be such good judges of the market value of live stock under the auction system as when they personally sold their stock either privately at their farms or at fairs and markets. The advantages to the buyers are varied and considerable. They can attend auction marts on occasions when they know the class of animals they require are to be sold, and are thereby saved the trouble and expense of perambulating the country in search of suitable beasts. One of the objections to purchasing at auction marts arises from an abuse of the system occasionally met with, consisting in the sellers themselves bidding through third parties in competition with *bona-fide* bidders. This system of bogus bidding, known in some districts as 'white-bonneting', is firmly prohibited in the best-conducted auction marts, but it is alleged that it is tolerated and winked at in others. It is not only highly objectionable, but illegal. The law on the matter is as follows:—'When a sale by auction is not notified to be subject to a right to bid on behalf of the seller, it shall not be lawful for the seller to bid himself or to employ any person to bid at such sale, or for the auctioneer knowingly to take any bid from the seller or any such person. Any sale contravening this rule may be treated as fraudulent by the buyer.' In North America all cattle, sheep, and pigs are put over the weighbridge, and their price is an agreed-on rate per 100 lb. live weight. In the process of selling they are graded or classified, and the price varies according to the particular class or quality they belong to. [J. G.]

Aucuba.—The Japanese laurel (*Aucuba japonica*) is one of the most useful of hardy evergreen shrubs. The mottled-leaved or female variety was introduced to this country from Japan in 1783, the smaller green-leaved male form not being introduced until 1850. To obtain a crop of the bright-red berries which are so decorative, it is necessary to grow both sexes in close proximity to each other. There are many varieties, which are all easily grown, and may be multiplied quite easily from one-year-old cuttings placed in a very moist, close frame, and kept almost dark until they are rooted. Market growers pack the cuttings as tightly as possible, and suspend them over a bed of wet moss in a heated frame, sprinkling them daily with water and covering them with thick brown paper. There is no shrub that will thrive in shaded and otherwise unfavourable positions to the same extent as this aucuba. It is better than rhododendron or common laurel for planting under trees. Drought does not appreciably injure it, the numerous fleshy roots and succulent stems and leaves enabling it to withstand the effects of a dry season in the most remarkable way. It is perfectly hardy in the British Isles, except in the coldest and most exposed localities. It withstands the smoke and grime of towns better than any other shrub, and it lives many years under conditions which would be fatal to most plants. The shoots and leaves are in great demand at Christmastime for decorations. [W. W.]

Augite, the commonest pyroxene (see art. PYROXENE), occurring in gabbros, dolerites, basalts, and many andesites. It is a silicate of calcium, magnesium, and iron, with alumina and ferric oxide, containing molecules of the composition $(Ca, Mg, Fe)\,SiO_3$, and others of the composition $Mg\,(Al, Fe''')_2\,SiO_6$. It is green or black, rusting sometimes to brown, commonly opaque, and occurs as short, stout, eight-sided prismatic crystals of the monoclinic system, or as small crystalline granules. In some igneous rocks it forms larger crystals round about felspar or olivine. *Diallage* is an altered variety, with shimmering surfaces developed in it, giving it an almost metallic lustre. Amphibole (actinolite or hornblende) develops frequently within augite or diallage as a product of slow change. Ordinary weathering produces chlorite, the lime being often added in soluble combinations to the soil. Though the freshness of the augite in many crystalline rocks of ancient date is remarkable, this mineral is no doubt responsible for some of the fertility of soils on basalt and dolerite, such as those in Co. Antrim and the Inner Hebrides. [G. A. J. C.]



Crystal of Augite from Basalt Soil, Schima, N. Borneo.

Augmentation.—In Scotland this is the name given to the form of action whereby a parish minister obtains an increase to his stipend. The stipend or salary is payable out of the teinds, and may be augmented from time to time, provided that there remain an amount of teind which has not already been allocated for payment of the minister's stipend, and that twenty years have elapsed from the date of the last augmentation. [D. B.]

August, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE FARM.—August is the principal harvest month all over the Midlands and south of England. Wheat, oats, barley, and beans are all ripe, and are cut and carried to the stackyard. After the land is cleared the stubble is cleaned as soon as possible with the broadshare, and ploughed up to get the advantage of the hot sun. Fallow work also is pushed on during the hot weather, and the weeds may be collected and burned.

Forage Crops.—Lucerne is cut for hay for the second time in the season during this month. It may be for the third time if it is a newly-laid-down crop. It is also cut for green fodder or may be grazed off. Cabbage, kail, and rape are in season, and are fed to sheep in folds. Cabbages are also fed to milk cows, and also maize, on the pastures to maintain the milk yield. Cabbage seeds are sown in beds for plants to be transplanted later in autumn and next spring. Rape, vetches, rye, and barley are sown for winter and early spring use. Crimson or Italian clover is sown on wheat stubble that has been cleaned.

Roots.—Mangolds and kohlrabi if running to seed should be cut down. They are not hoed now, as they are of sufficient growth to keep ahead of the weeds. Sow turnips broadcast, or in rows on the flat for winter use. Hand-hoe late-sown turnips for the second time. Potato lifting continues in succession.

Manuring.—Sow rape and mustard for green manuring, especially for potatoes. Mustard is sometimes ploughed in before wheat, as it is believed to be obnoxious to wireworms. In the intervals of harvesting, farmyard manure can be carted out on to the stubbles or young 'seeds'.

Grass lands are becoming dry and parched up towards this month, and the stock needs to be supplied with forage or to be turned on to the aftermaths. Grass seeds are sown on fallow at this season where the land is being sown down without a crop. The second cut of mixture hay is saved during this month.

Special Crops.—Gorse is cut and fed to stock after being bruised up. Peas and tares are harvested during this month also. Buckwheat, flax, hemp, mustard, radish, and all other crops of a special nature are mostly harvested for seed this month and the next.

Stock.—*Horses.*—The work of this month is very severe on the horses, as it mainly consists of reaping the corn crops and carting in the same. They therefore require good supplies of food, supplemented with green cut forage such as lucerne or clover. A great many foals are weaned now, and have to be well attended to or will get low in condition. Flies are very troublesome at this season, but the horses can be made easier by spraying a little paraffin over them, which will keep the pests off for a few days.

Dairy.—The pastures begin to get very low, so the acreage has to be increased by allowing the cows on to the aftermaths. Green fodder such as maize and cabbage are fed to the cows on the pasture to keep up the milk yield, which has a tendency to get low at this time of the year. The food which they get outside should be supplemented by a little cake in the house. The attacks of the warble fly and other pests are very bad, and will affect the yield of milk, and it is a good plan to put a smear of sheep dip on the cows' backs to counteract the attacks. The fences to the pastures ought to be well looked after or the cows may break out. If they get into a field of clover or lucerne they would probably gorge themselves and suffer from hoven. The water holes must be attended to. Cheese and buttermaking still continue. Milk yields more cheese per gallon in the autumn. Get in a store of brewer's grains, as they are cheap now. Pit them well so as to be practically air-tight, and they will keep fresh for a long time.

Store Cattle.—The same remarks apply to store cattle as to milch cows when on pasture. Green cut fodder is fed to cattle that are kept in yards. The sale of 'stores' is effected during this month owing to the shortage of pasture.

Sheep.—This is a trying month for the flock-master if the summer has been at all droughty. The sheep can be allowed on to the aftermaths to increase their acreage of pasture. Early tankard turnips, cabbage, kail, and rape are fed to them, especially to the lambs, which must essentially be supplied with fresh food. They may be allowed on to the stubbles that have been cleared, for the greater part of the day. If there is much shelled-out grain lying on the ground they should not be allowed on for long. A sharp lookout must be kept for flyblows.

Pigs.—Store pigs can be turned out on to the stubbles. If they are still kept in yards their feeding can be supplemented by cut forage and cabbage. The sweepings of the harvest carts can also be given to them.

Poultry.—No hatching is done during this month. The feeding is reduced as the corn is carted to the yard, providing plenty of picking. Young poultry are housed out on to the stubbles in movable houses. Geese are driven on to the stubbles to forage. Old hens should not be allowed to wander far from the homestead or they will drop from apoplexy. Eggs are abundant and cheap, and are preserved for winter use. The cockerels are sold off, the best being kept for stock purposes at the rate of one for six or eight hens. [P. M'C.]

2. Northern Britain

The principal work of the month will be the stacking of the hay crop. Unless hay is very dry, or too ripe when put in the field rick, it is very seldom that it is ready to put into the large rick earlier than three weeks after it has been put up. A beginning should be made with the rye grass and clover hay first, to be followed later on by the timothy and natural meadows. If thatch has not already been prepared, advantage should be taken of unfavourable weather to have it made ready, so that it may be put on after the rick has had a day or two to settle down. If convenient the ricks are better to be pulled round the side before being thatched; but as thatching can often be proceeded with in weather which is unfavourable for dressing the side of a rick, it need not be delayed on this account.

Binders and reapers should be thoroughly examined and put in good working order. It is not time to look to these when the grain is ready to cut, as it may then be found that extensive repairs are wanted, and there may not then be time to get them executed. It is only about one year in five or six that there is much wheat ready for harvesting in the West in this month, but every second or third year considerable areas of oats are cut in August. Always begin to cut the oat crop with a considerable tinge of green on the ear, as it ripens considerably while standing in the stook, and the loss from cutting too green is usually trifling compared with what generally happens, before reaping is finished, from shedding owing to overripeness. In the earlier districts potato digging will be in full swing, and where there are many of them will demand the full horse power of the farm.

If it is intended to renew any of the timothy meadows, and it is not desired to put them through a rotation of cropping, they may very profitably be broken up during this month and resown, a full crop of hay being reaped the following year. This is an important month for the hill farmer, as it brings with it the first of the lamb sales. The best lambs or the 'tops' are drawn from the flock and sent to one or other of the numerous markets, unless the whole flock is in a somewhat backward condition, in which case they may be retained for a few weeks longer. The ewes do not settle well for the first few days after the lambs are removed, and the shepherd is consequently kept busy attending to them. The maggot fly is also apt to be severe at this time, and as prevention is better than cure, dipping and cleaning should have attention.

Where lambs have been reared they should be sold off as soon as they are ready for the market, as after the beginning of this month they may get larger, but they seldom increase in value. If lambs or older sheep are fed off on rape, cabbages, or rye grass, they should be bought in and gradually accustomed to the new food. Where pastures have been fully stocked, cows in milk will now require some succulent food, such as second-cut clover, Italian, or cabbages. Where winter milk is produced, newly-calved cows should be freely purchased from now forward. [J. S.]

August, Calendar of Garden Operations for.—

1. SOUTHERN

The hose and watering pot are generally in great demand during this month. Should the weather be exceptionally dry, a mulch with short manure, grass from the lawn, cleanings from ponds, &c., placed over the soil in borders and beds outside serves to keep the roots of the plants moist. Help is also afforded to plants threatened with injury from drought, by stirring the surface soil with a hoe, a layer of loose dry soil preventing evaporation.

Seeds of plants for winter and spring crops will now require to be sown, such as onions, spinach, cabbage, lettuce, and cauliflower. In dry weather the soil should be dug over immediately before the seed is sown, and if manure is to be given, it should be applied as a thin mulch so as to prevent the surface from drying before the seeds have germinated. A sowing of Early Horn Carrots may be made now, as they will be fit for use in March or April. Cauliflowers for early summer are sown in mid August, and the plants, when large enough, pricked out 6 in. apart in a frame. A sowing of endive should be made for plants to come in for use in spring. Radishes also, if sown now in a border facing north or west, will be fit for use in late autumn or winter, the French Breakfast, or Turnip-rooted, being the most serviceable at this season. A good sowing of spinach for a winter supply should be made about the middle of the month. Broccoli and borecole may be planted for a late crop. Celery will require plenty of water, and to be earthed up as growth proceeds. Onions ought to be ready for gathering before the end of the month. They should be spread on the ground and left to dry in the sun until they are fit for bunching and placing in the store.

Tomatoes in the open air should be yielding a good supply of fruit; in dry weather they will require help from the watering pot, and a little stimulant, such as Clay's fertilizer or guano. Gooseberries, currants, and raspberries will be fit for gathering, and this operation is best performed when the weather is cool and dry. Peaches, nectarines, apricots, plums, early apples and pears, should be gathered as they ripen, and it pays to handle these fruits carefully so as not to bruise them, which detracts from their quality. If wasps are troublesome, bottle traps should be set for them. It is good economy to spend a few shillings on small meshed netting to be used as a protection for wall and other fruit against birds and other pilferers. The nailing in and thinning of the summer shoots of wall trees must receive attention, and it is not too late in August to summer-prune these where the shoots are stronger than is desirable.

August is the best month in which to make new plantations of strawberries; strong healthy runners should be planted 18 in. apart in rows 3 ft. apart, and well watered if necessary. Established strawberries will require to be relieved of runners and weeds, and on dry soil a mulch of good stable dung should be applied after the rows have been cleaned.

Pot plants generally are better out-of-doors than under glass at this time of year, as they make sturdier growth and require less attention than when they are kept in houses or frames. The propagation of such bedding plants as pelargoniums must be started not later than the middle of August, when cuttings may be taken from the plants in the beds and borders, set in shallow boxes containing light soil, and placed against a south wall where they will get full sunshine. Border carnations should be layered, herbaceous and alpine plants intended for division in the spring should now be topdressed with good soil, working it in amongst the shoots to encourage the formation of new roots. Plants in borders will require thinning, staking, and training. Chrysanthemums, both in pots and in the borders, must be regularly fed and watered. Michaelmas Daisies should be staked out loosely, and if the shoots are numerous, thinned so that each plant will have a loose, elegant appearance. Dahlias will require to be tied safely, and the superfluous shoots removed. [W. W.]

2. NORTHERN

As bush fruits ripen, the gathering of the crops must receive prompt attention and they should be secured when in their best condition, whether for home consumption or marketing. Gather all fruits when slightly *under* ripe rather than allow them to get *dead* ripe. Overripe fruit is useless for the market, and even dangerous for food. Where weeds have got ahead during the fruit gathering, pull out and burn all those that are seeding, and hoe down the smaller ones. Clear off the haulm of earlier peas as soon as the crop is gathered, and keep the garden as tidy as possible. Where early potatoes have been grown, the ground should be cleaned and prepared for strawberries or other crop. If the ground is in good heart and of a free texture it need not be dug, but if stiffish and poor it must be thoroughly well manured and trenched if necessary. If the strawberry plants are set out early in August they will make some growth and stand the winter better than those planted later in the season. The early-potato border is also an excellent place whereon to raise young cabbage plants to stand over the winter for spring planting. Do not dig the ground; merely clean it with the hoe and rake, and sow the seeds in lines a foot apart. Sow thinly early, late, and red cabbages, greens, Brussels sprouts, savoys, and cauliflowers, the latter to be wintered in frames. After sowing, tread the ground moderately firm; the plants will thus stand the winter better. In warm soils especially, a sowing of parsley should be made. This will stand the winter and give an earlier supply. Those who wish to grow the East Lothian Stocks in quantity ought to sow these at the same time as above, and treat them similar to the cauliflower.

Worn-out plantations of strawberries may be cleared off, or preferably the break may be made the spoil-heap of the garden refuse for a time, and when opportunity permits have the whole trenched in, thus saving work and adding fertility to the soil. Prepare and lay in runners from strawberry plants for spring planting. It pays to select the best and to give some care to the young plants.

Early celery will require attention towards blanching by 'earthing up'. There is no gain in earthing up the main crops too soon, but see that they do not suffer from drought. Shallots and early onions must be secured as they ripen. If the main crop of onions keep growing too vigorously and inclined to have thick-necked stems, they should be checked by bending or half twisting the stems.

Frequently during this month, with excess of heat and moisture there is a glut of cauliflowers. Should such occur, and a blank in the supply be foreseen, this dreaded evil may be minimized by pulling up the plants when the heads are seen opening out from the leaves, and after stripping off the roughest leaves either hanging up the plants by the heels, or planting them in a bed of damp sand in a cool cellar or shed where there is a moderate circulation of air. Cauliflower so treated properly will keep for two or three weeks, and if put in cold water with some salt a few hours before cooking, will be quite palatable. Where pot herbs are required for winter use, these should be cut and dried. The simplest and best plan is to cut and tie them in small bunches, and hang them up in a cool, airy shed; large bunches are apt to heat. The herbs most commonly in demand are mint, sage, thyme, and tarragon. Where vegetable marrows are grown, attention must be paid to the vines so that they do not overcrowd; for table use, cut the fruit when the skin is tender.

The removal of dead or exhausted flower stems from perennial plants and the marking of those from which seed is to be saved is part of the regular duty. See that all strong-growing subjects are properly secured against wind storms. Mulch or manure gross-feeding plants, and protect 'show' blooms from 'wind and weather'. Make preparations for the propagation of those plants which require protection during winter, or of those desired to be increased in quantity. Carnations ought to be layered as soon as the shoots are large enough to be handled. Where the soil is light the layering can be done in it; but in heavy soils it is desirable that a rooting medium of sand and leaf mould be used. For details see art. LAYERING.

If Sweet Peas are podding too freely, remove the pods to prevent exhaustion, and give a supply of liquid manure to maintain the vigour necessary for a supply of fresh bloom.

Where rose-budding is not practised, the stock of certain kinds, notably the old garden varieties, may be increased by cuttings. Pull off the half-ripened side shoots, leaving a slight heel; trim the heel and shorten off the tops, leaving the cutting from 6 to 9 in. in length. Insert the cuttings in a shady place, using a little sand amongst the ordinary soil to assist the rooting. [J. WH.]

Aulacaspis rosæ (the Rose Scale).—Both wild and cultivated roses are attacked by this Coccid, out-of-doors and under glass. The female scale is pure white at first, with a small yellow speck near the margin—the cast larval skin—rounded, flat, and rather thick. The insect under the scale is deep-orange to crimson, so also are the ova and six-legged young. The male scale is white, very small, and elongate; they hatch out in May and June, and are bright-red. The females oviposit in August, and the orange-red larvæ crawl over the bushes, frequently in such numbers that they give them a distinct reddish tinge. The insects encrust the stems and twigs but not leaves, and when very numerous kill the bushes.

Treatment is best carried out in August, when the bushes should be sprayed with soft soap and quassia to kill the naked larvæ, or the stem and twigs may be treated with paraffin emulsion in winter. The Gold Crest Wren feeds upon this scale. [F. V. T.]

Auricula.—*Primula Auricula* is one of the oldest of garden flowers, numerous varieties of it being known and grown by fanciers nearly

300 years ago. It is not certain, however, that the show and alpine auriculas cultivated to-day are all forms of one species. In the north of England there are auricula clubs or societies, and the plants are exhibited by their members at their weekly or monthly meetings, usually held on Saturday evenings in the room of a public-house, where the points and qualities of the plants are discussed with keen interest. No plants reveal such an extraordinary diversity of flower-painting as auriculas do. The show section is divided into four sections, namely, green-edged, grey-edged, white-edged, and selfs. The alpine section is divided into white centred and yellow centred. *Green-edged* have green leaves and flowers densely coated in the centre with white powder, next to which is a ground colour of violet or crimson, and the edge is clear green without powder. *Grey-edged* differs from green-edged in having the green margin almost entirely hidden by a thick coating of powder. *White-edged* have this powder pure white like the centre of the flower. *Selfs* have a uniform colour with a white eye. The plants are grown in unheated frames, and are planted singly in 4-in. pots in a loamy soil in which pounded oyster shell is mixed, and they are put into fresh soil every year immediately after the flowering season is over. In summer they are placed in the open on the shaded side of a wall, where they are left till November, when they are replaced in the frame and protected during very severe frost with mats or boards. Artificial heat is not required. Watering at all times must be done with care; the soil should never be saturated, nor should the leaves ever be wetted. The alpine sorts are easily grown in a border outside. Seeds, if purchased from a fancier of repute, will yield a large percentage of good varieties. The best-named varieties cannot be purchased for less than 10*s.* or 20*s.* each.

[W. W.]

लाल बहादुर शास्त्री राष्ट्रीय प्रशासन अकादमी, पुस्तकालय
Lal Bahadur Shastri National Academy of Administration, Library
मसूरी
MUSSOORIE.

यह पुस्तक निम्नांकित तारीख तक वापिस करनी है ।
This book is to be returned on the date last stamped.

दिनांक Date	उधारकर्ता की संख्या Borrower's No.	दिनांक Date	उधारकर्ता की संख्या Borrower's No.

630·03
Sta

अवाप्ति संख्या 118875
Acc No. ११५६

वर्ग संख्या
Class No.

पुस्तक संख्या
Book No.

लेखक
Author

शीर्षक
Title The standard cyclopedia of modern agriculture & rural economy.
V.1

निर्गम दिनांक Date of Issue	उधारकर्ता की संख्या Borrower's No.	हस्ताक्षर Signature
		११५६

R
630·03
Sta
V.1

LIBRARY
LAL BAHADUR SHASTRI
National Academy of Administration
MUSSOORIE

Accession No. 118875

1. Books are issued for 15 days only but may have to be recalled earlier if urgently required.
2. An over-due charge of 25 Paise per day per volume will be charged.
3. Books may be renewed on request, at the discretion of the Librarian.
4. Periodicals, Rare and Reference books may not be issued and may be consulted only in the Library.
5. Books lost, defaced or injured in any way shall have to be replaced or its double price shall be paid by the borrower.